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TECHNICAL REPORT
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DESIGN OF A PILOT PLANT FOR VACUUM INFUSION OF HIGH LIPOIDAL LIQUIDS INTO DRIED FOODS

BY

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FOOD ENGINEERING DIRECTORATE

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The objective of this contract was to design an automatic semicontinuous pilot plant scale vacuum infusion system complete with specifications and engineering and construction drawings. Also included are recommendations for commercially available equipment and estimated cost of construction. The design was based on laboratory work conducted at Natick, where vacuum infusion of high lipoidal liquids in void spaces of dried food stuffs produced high caloric-dense ration items, was successfully demonstrated.

The design also provides for manual operation as well as automatic. A typical infusion cycle using the designed system is as follows: the food matrix tray is placed in a vacuum chamber by a delivery conveyor; the vacuum is reduced to a predetermined level; the lipoidal liquid is drawn into the chamber and envelopes the matrices; the liquid is drained, and vacuum released; then the infused matrices are removed and cooled on a conveyor belt equipped with a chiller hood.

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PREFACE

This research on design of a pilot plant for vacuum infusion of high lipoidal liquids into dried foods was performed by Engineering Incorporated, Hampton, VA, under U.S. Army Natick RD&E Center contract DAAK60-85-C-0008 during the period July 1984 to July 1985.

The Natick Project Officer was Mr. Jack L. Briggs.

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DESIGN OF A PILOT PLANT FOR VACUUM INFUSION OF HIGH LIPOIDAL LIQUIDS INTO DRIED FOODS

1.0 GENERAL

1.1 Introduction

Vacuum infusion of high lipoidal liquids into the void spaces of dried food products has been successfully demonstrated at the laboratory bench level. This new technology is used in producing high caloric-dense dried food products. This technology involves evacuating a chamber containing dried food products and then releasing a high lipoidal liquid into the chamber, thus resulting in the liquid being forced into all the void spaces of the food products.

Since no such technology exists in industry, it is necessary to fabricate a pilot plant piece of equipment to produce quantities of vacuum infused food products sufficient for limited field testing. In recognition of the developmental nature of the application of this system and the potential need for direct scale-up to larger production capacity, a system is proposed that has high versatility and simplicity. The proposed system provides the user with the options of manual operation, or a continuously running, automated system.

1.2 General Description

The principal element of the system is a double-access, vacuum chamber designed to conform to the ASME pressure vessel code. The double-access arrangement allows the food product to travel in a single direction through the processing equipment, enhancing the scale-up potential of this system. The chamber contains the thermally controlled infusion liquid immersion dish into which the food tray is immersed by lowering the tray carriage via an externally actuated pneumatic cylinder.

The food trays are supplied to the chamber entrance by the delivery conveyor, which cycles toward and away from the chamber to permit opening and closing the chamber entrance door. The food trays are moved from the chamber exit by the extraction conveyor, which cycles toward and away from the chamber exit to permit opening and closing the chamber exit door. The trays are placed on the delivery belt, and removed from the extraction belt, by systems provided by others.

Temperature control of the lipoidal liquid is accomplished by installing a removable, water jacketed, immersion dish inside a "standard design" cylindrical pressure vessel with dished head doors - rather than by shaping and heating the bottom of the pressure vessel. Thus, the immersion dish is not a part of the pressure shell, and the temperature of the fluid in the immersion dish can be controlled independently of the shell and of the infusion liquid reservoir.

The thermally controlled infusion liquid reservoir is provided with a pump which circulates infusion liquid through the in-line filter for maintaining liquid quality, empties the reservoir, and pumps cleaning solutions through the system for periodic cleaning. Other systems used to support the processes are:

- steam spray system on the conveyors
- water heating system
- hot air system
- cool air system
- steam cleaning system

The electronic controls for the infusion system are designed for manual and automatic operation. In the manual mode, the system operates from the operator control console with operator assistance required while process temperatures and pressures are monitored and displayed at the control console. In automatic mode, the cycle and dwell times are entered into the system for continuous food processing. A microprocessor based programmable logic controller monitors the temperatures, pressures, and sequencing functions of the process, and accepts input data and process limits from the control console.

The interlock, safeguarding, and operational steps are implemented through the programmable logic controller. Emergency stops and manual overrides for automatic equipment are designed in to assure overall plant safety. Details of each system are provided in the following sections.

2.0 MECHANICAL SYSTEMS

The mechanical system design is an optimization of design criteria, shown in Figure 1. In addition to the basic design criteria, the equipment must operate within a specified range of utility services shown in Figure 2. An elevation view of the equipment is shown in Figure 3, and will be used as a starting point for the following discussion. All components are rated for sanitary food service.

2.1 General

2.1.1 Pressure Vessel (See Figure 4 and Drawing D12557.) The double door vacuum chamber was designed to maximize use of commercially available components in accordance with the ASME Code. The vessel has an inside diameter of 42 inches and a length of 42 inches. This size is adequate for mounting all required components and allows interior cleaning with components installed. The vessel interior is epoxy painted to aid in cleaning. Vessel penetrations are provided for tray immersion cylinder, vacuum, hot air system, lipoidal liquid system, hot water system, instrumentation leads, and lighted viewing parts.

The pressure vessel doors are operated by pneumatic cylinders and held in the closed position until the vacuum seals the doors. The cylinders will also hold the doors shut in the event that the chamber becomes pressurized to approximately 2 psi at which point the doors open slightly to vent the chamber as a safety feature. During normal operation the doors are released when the warm air begins to blow over the processed food, providing added air flow control.

The use of standard components in the design will enable a number of pressure vessel manufacturers to easily manufacture the vessel.

- EVACUATION TO 1 MMHG
- PROCESS TEMPERATURE CONTROL FROM AMBIENT TO 150° F ± 3°
- 10 MINUTE CYCLE TIME
- TRAY COOL-DOWN TIME - 5 MINUTES MAXIMUM; 120° TO 60° F
- WARM AIR SYSTEM, 90° TO 120° F, CONTROLLABLE
- PRODUCT TRAY, 2' X 1' X .5' WITH 10 LB. LOAD CAPABILITY
- MONITORING AND CONTROL OF PROCESS VARIABLES AND SEQUENCE
- COMPLIANCE WITH OSHA, NEC, FDA, ASME AND USDA
- COMMERCIAL COMPONENT SELECTION PER MIL-STD-143
- INCORPORATE PRODUCTION SCALE-UP FEATURES
- SANITARY FEATURES BUILT-IN

Figure 1. — System Design Criteria.

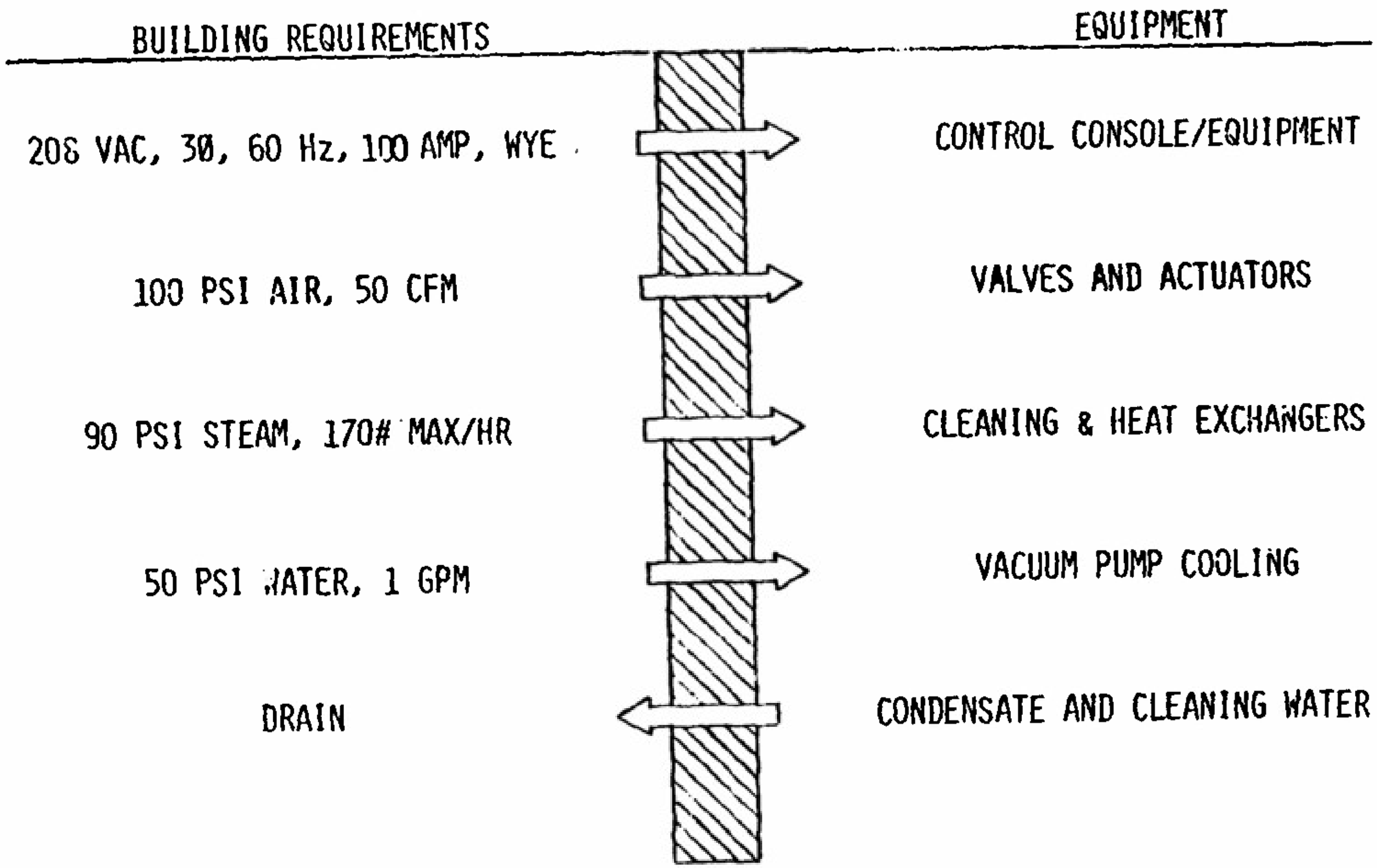

Figure 2. — System Interfaces.

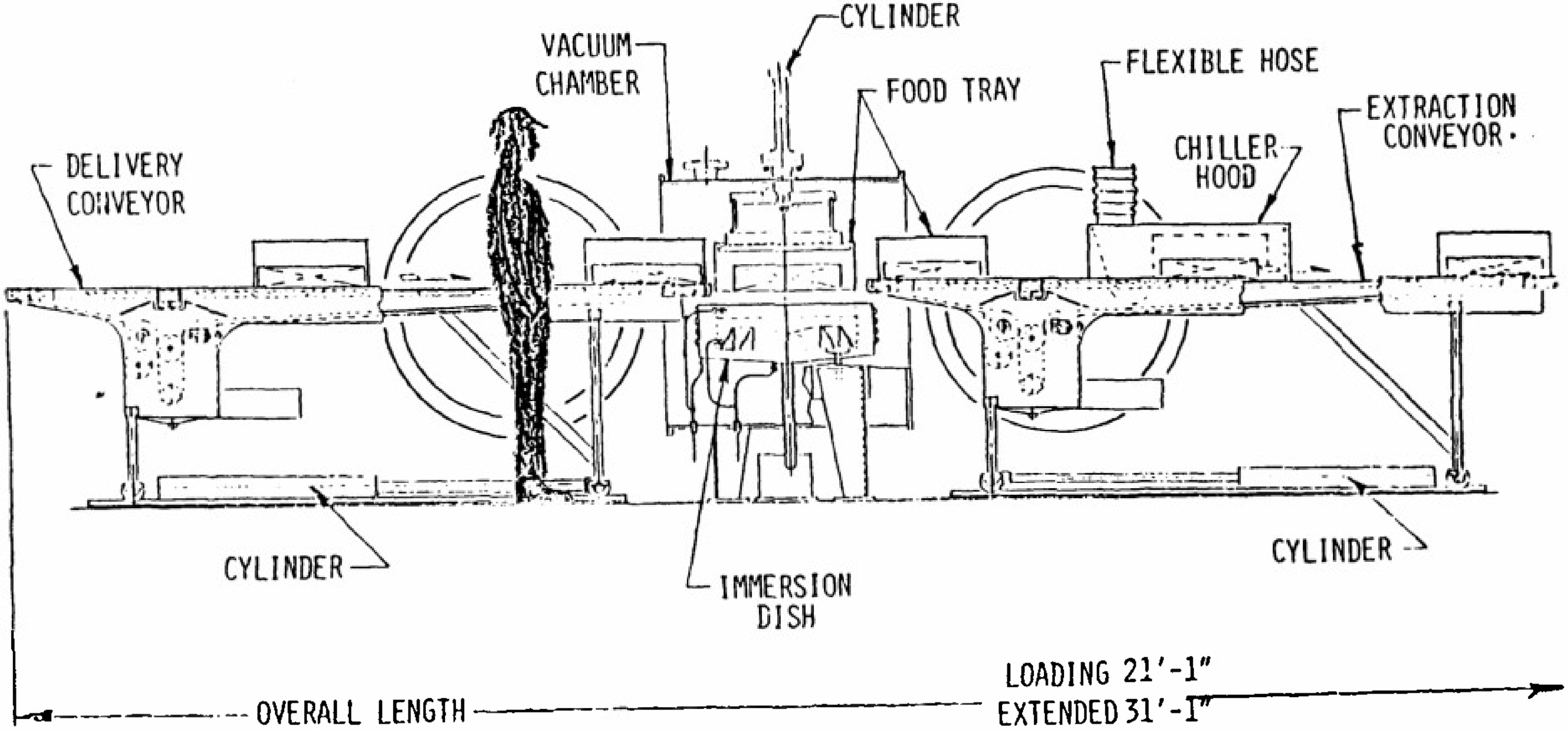

Figure 3. - Elevated Equipment Arrangement.

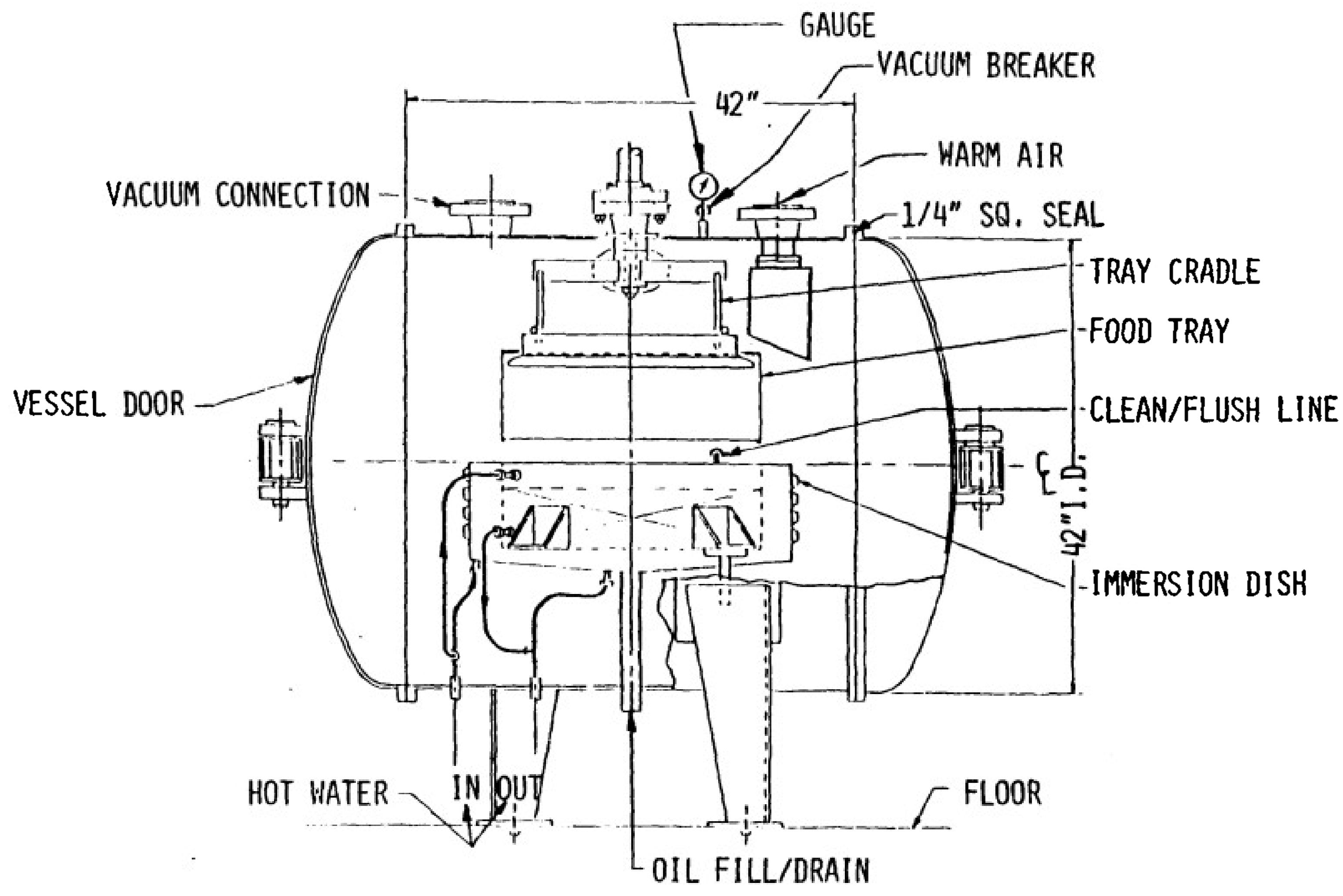

Figure 4. — Vacuum Chamber - Side Elevation.

2.1.2 Immersion Dish (See Figure 4 and Drawing D12562). The immersion dish is a water jacketed open kettle inside the pressure vessel and is used to contain the lipoidal liquid and maintain the liquid at the required temperature. The dish is 30 inches inside diameter with a maximum depth of 9 inches. The liquid temperature is controlled by varying the flow of hot water through the kettle jacket.

2.1.3 Food Trays (See Figure 5 and Drawing D12562). The food trays are manufactured from a stainless steel wire mesh product to meet the U.S. Department of Agriculture (USDA) requirements for food handling. They are approximately 24-3/8 inches by 12 inches wide by 8 inches deep and are equipped with a cover to contain the food product during the immersion process. The food trays are carried to the vessel by the conveyor where the tray engages the immersion device. After the immersion process is complete the next tray pushes the completed tray onto the exit conveyor.

2.1.4 Warm Air System (See Figure 6 and Drawing D12561). After the food immersion process is complete, the tray is raised from the lipoidal liquid and drained by two processes. The first process shakes the food tray causing any liquid droplets to fall back into the immersion dish. A warm air system then blows filtered air over the food product to complete the excess liquid removal. The air temperature is maintained between 90°F (32°C) and 120° (49°C) by a steam coil heating system. Air flow over the food is optimized by a manifold that was designed with a single attachment to the vessel and with a hinged end plate to allow cleaning without removal.

2.1.5 Viewing Ports (See Drawing D12555). The chamber has two viewing ports sized to provide ample area for observing the infusion process. Lights are provided on the vessel exterior of the ports to aid in viewing.

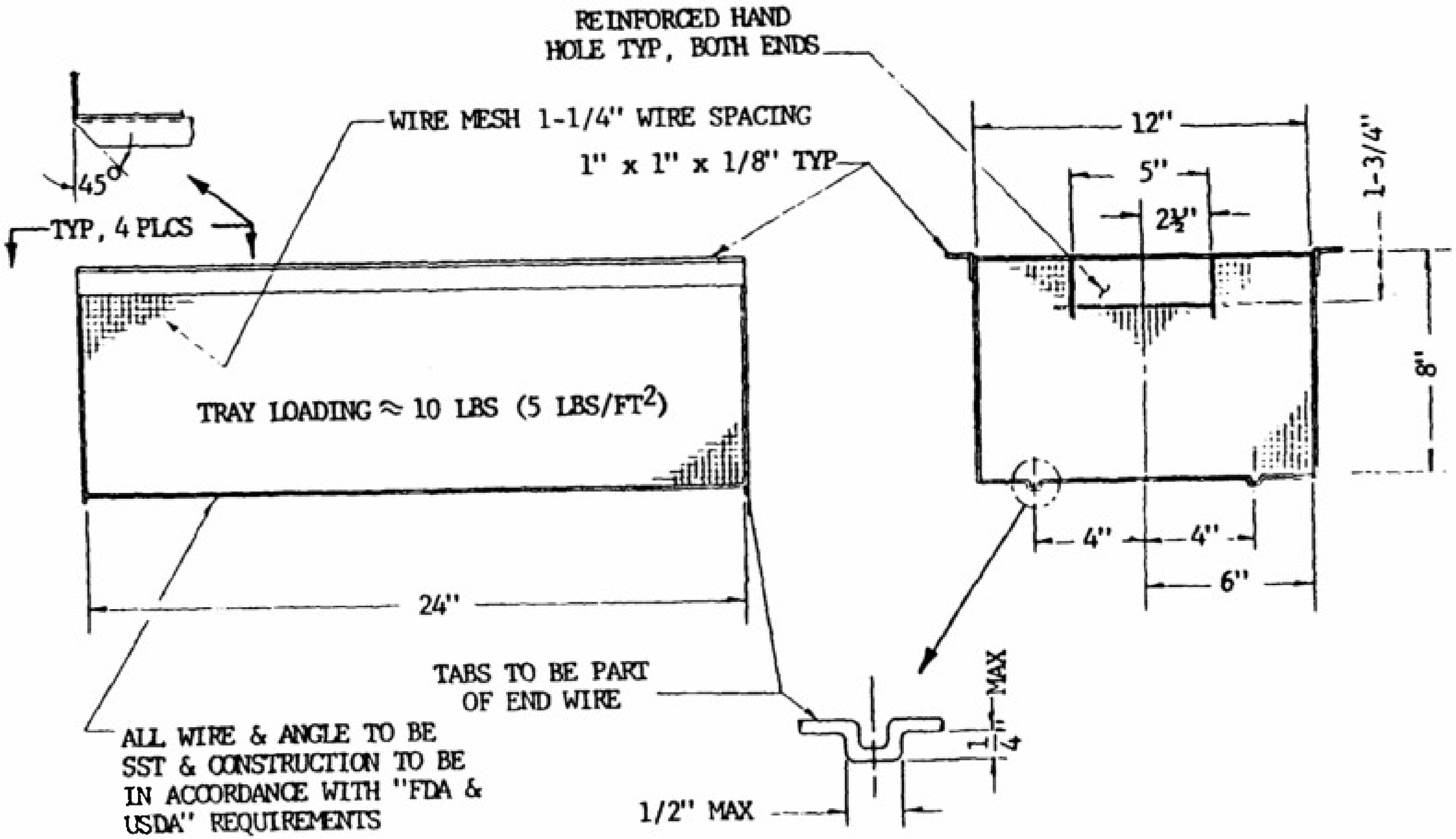

Figure 5. — Food Tray.

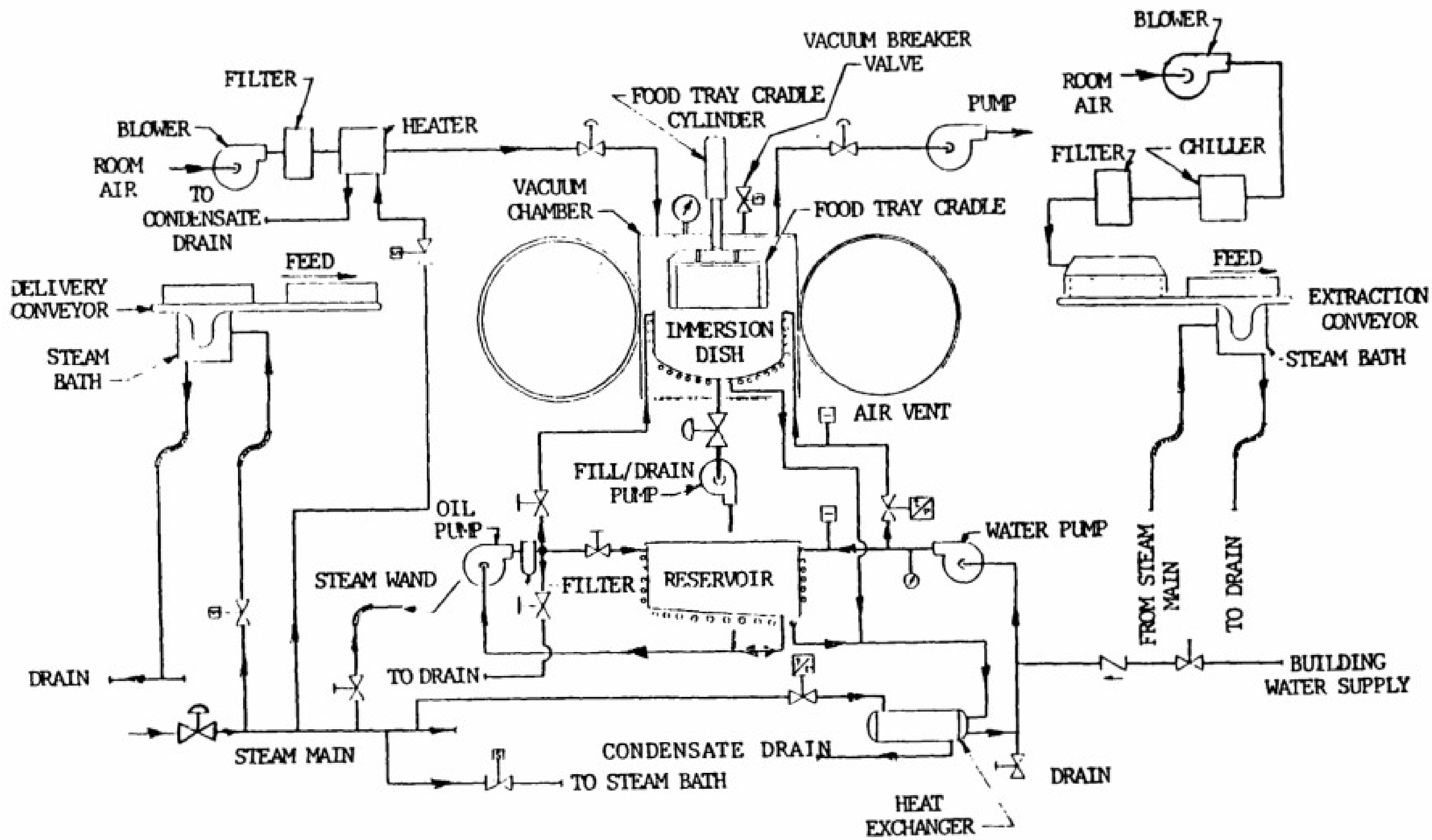

Figure 6. — Mechanical System Diagram.

2.1.6 Vacuum Pumping System (See Figure 6 and Drawing D12556). The vacuum pumping system consists of standard components integrated into a custom system matched to the infusion process. The vacuum system is sized to provide a one minute pump down time with a dry, clean chamber. Actual run times required to reach a 1 torr vacuum level will depend on a number of variables including the type of lipoidal liquid in use, the cleanliness of the vessel (longer pumping time at the end of a shift), vessel temperature, the type of food being infused, etc. The vacuum pump is protected from food outgassing products by a refrigerated baffle which prevents food products from contaminating the vacuum pump lubricating oil. The baffle also traps any pump lubricant vapors which may try to backstream to the vessel. A vacuum isolation valve is modulated while the vacuum pump continuously runs to maintain the desired setpoint.

2.2 Lipoidal Liquid Systems: The lipoidal liquid is provided at the proper conditions to the immersion dish from an external reservoir through a liquid distribution system. The overall mechanical system diagram is shown in Figure 6. The basic subsystems which support the infusion process are:

- o reservoir
- o recirculation and filtration circuit
- o hot water heating system
- o steam system

These systems provide lipoidal liquid to the immersion dish at the proper temperature, filter any suspended food particles from the liquid after the immersion process, and store liquid that will be needed for each processing run.

2.2.1 Reservoir (See Drawing D12562). The reservoir is constructed of an embossed double wall stainless steel shell to provide a hot water jacket which will maintain the lipoidal liquid at the required temperature. A hinged cover is provided on the reservoir to maintain cleanliness during use while facilitating filling and clean up operations. The system may be drained by using the recirculation pump, after shifting some valve positions, or by a manual drain. The reservoir is sized to contain all the lipoidal liquid expected for a 2 hour production run as determined below:

Required Liquid Source	Volume (Cubic Feet)
Immersion Dish & Piping	2.60
Liquid Consumed in Production	1.50
Reserve	.2
Total	4.3

Assuming a lipoidal liquid specific gravity of .9, the entire infusion system charge will then weigh:

$$W = \text{Volume} \times \text{SG} \times \text{Density of Water}$$

$$= 4.3 \times .9 \times 62.4 = 242 \text{ pounds}$$

The reservoir is capable of holding 300 pounds of lipoidal liquid as a maximum charge.

The infusion liquid temperature is maintained by circulating hot water through the reservoir jacket. The hot water is regulated by two automatic temperature controllers within the hot water circulation subsystem, which is described in detail in Section 2.2.3.

2.2.2 <u>Recirculation and Filtration Circuit</u> (See Figure 6 and Drawing D12556). Since the infusion system is a research facility, it is necessary that the systems allow use of various liquids to provide data and study the most efficient methods to ascertain the optimum infusion liquid into various products. The viscosity of the liquids at the processing temperature ranges from 800 to 6000 centipoise. This large range of viscosity precluded using the vacuum to fill and drain the immersion dish because sanitary pipe and fittings were not readily available in sizes necessary to meet the one minute fill and drain criteria. Based on the analysis of the system and operating requirements, transfer pumps were selected to fill and drain the immersion dish and recirculate the liquid.

The recirculation pump cycles the infusion liquid out of the reservoir through a 100 mesh strainer to remove suspended food particles from the fluid. The liquid then is returned to the reservoir for use in the infusion process. The recirculation pump runs continuously to agitate the liquid and aid in maintaining a uniform temperature. The recirculation pump is also used to drain the lipoidal liquid at the end of a process run by shifting two manual valves. After the reservoir has been drained the tank can then be filled with a cleaning solution, which can be circulated to remove heavy deposits from the system. A third manual valve allows the cleaning solution to be pumped into the immersion dish for cleaning. The recirculation pump provides a 5-gallon per minute (gpm) flow rate and up to 85 pounds per square inch absolute (psia). The low flow rate for the recirculation pump was required to allow continuous operation when the fill/drain pump is operating. The pressure capacity of the pump allows forcing of the viscous fluid through the strainer unit. The strainer's capacity is twice the pump output pressure, therefore, a single strainer unit should be sufficient for normal use. Additional units can be paralleled easily into the system if the need arises.

This system is adaptable to liquids with even higher viscosities. The viscosity limit should be determined by experiment using the actual system since the governing flow equations begin to lose their accuracy as the Reynolds number for flow drop below 100. The system Reynolds number is approximately 1.

The pumps chosen for transfer and recirculation are of the rotary lobe positive displacement type. To operate with viscous liquids, the internal clearances between the parts must be larger to allow the proper pump function. The larger liquid clearances allow the pump to run dry without damage but also insure that the pump can only operate with a positive suction head, or with an unbroken fluid column. These pumps are commonly used in food processing and are used to move liquids up to one million centipoise in viscosity.

To close off the fill and drain pipe to the immersion dish, a remote actuated food service poppet valve is used. This valve has a USDA approved rubber seating surface which is rated for 65 psi differential pressure. This valve is rated "clean-in-place type" but is easily disassembled for servicing. The piping design for this system incorporates food service clamped flange connections with O-ring seals. Any section or run of pipe can be disconnected from the system without a complete disassembly of the entire system.

2.2.3 Hot Water Heating System (See Figure 6 and Drawing D12555). A hot water system is used to heat and maintain the temperature of the lipoidal liquid in the reservoir and the immersion dish. Each vessel has a water jacket, selected to allow uniform heat input to the liquid. The water entering the system is heated to the required temperature in a steam/water heat exchanger. The steam rate is automatically controlled to maintain the water temperature at the setpoint. Hot water is circulated to the components by a centrifugal pump.

The immersion dish can be maintained at a temperature equal to or below the reservoir by use of a separate temperature controller and a modulating valve in the hot water line. Vents and drains allow trouble free filling and flushing of the system.

2.2.4 **Steam System** (See Figure 6 and Drawing D12555). The steam system is supplied from an available 90 psig supply and is used to heat water, heat air, and to clean the conveyors. The steam rate to the water heat exchanger is automatically controlled to maintain water temperature. The warm air is heated in a steam-to-air heat exchanger to maintain the air temperature at 90°F to 120°F by modulating steam flow rate. Steam supply pressure is reduced at the heat exchanger to five psig for air heating.

The steam system also supplies steam for automatically cleaning the conveyor systems while they are operating through nozzles enclosed on each conveyor. For additional cleaning of conveyors and other components, a steam cleaning wand with soap dispenser/mixer is provided. This system allows components to be soaped and then rinsed to ensure maximum cleanliness.

2.3 **Conveyors** (See Figure 7 and Drawings D12559 & D12560). The entrance and exit conveyor systems are similar in construction. The exit conveyor has a chiller hood and the last portion of this conveyor consists of a slideway. These differences will be covered in more detail once the function of each unit is discussed.

2.3.1 **Entrance Conveyor:** The entrance conveyor is loaded by the system operator with filled food trays and at the proper time in the system cycle the conveyor is driven by a pneumatic cylinder toward the open vacuum chamber. A limit switch stops the conveyor motion at a preset position, and starts the belt motion. The belt feeds a loaded food tray onto the tray cradle. The belt motion stops when the next food tray, loaded on the conveyor, contacts a tray position limit switch at the front of the conveyor. The conveyor assembly then retracts and the infusion cycle continues.

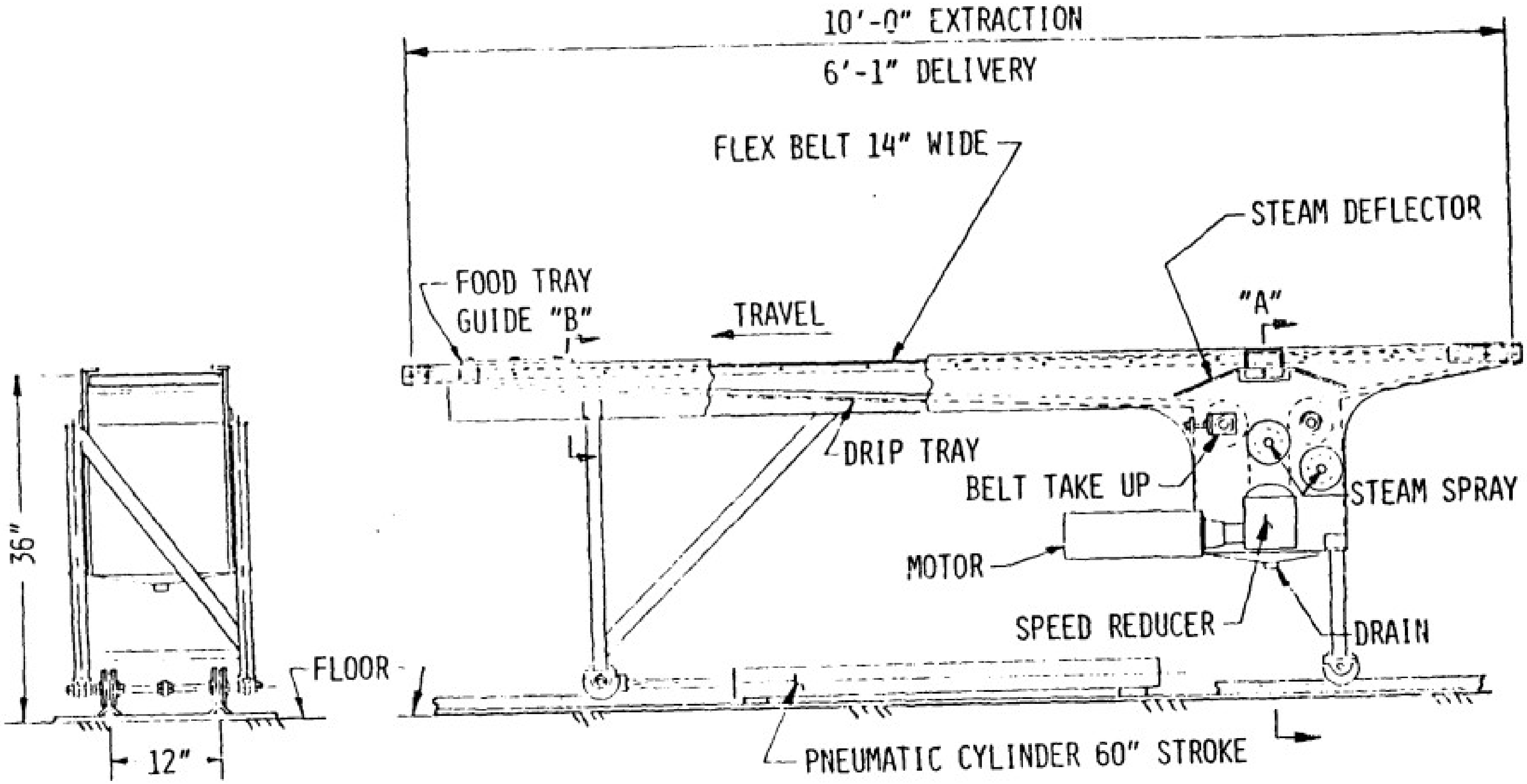

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Figure 7. — Delivery/Extraction Conveyor.

2.3.2 Exit Conveyor: The exit conveyor has a similar function, with differences to be discussed. The exit conveyor begins it's cycle by stroking into the open vacuum chamber, and stopping 2 to 3 inches away from engaging the food tray on the cradle. The entrance conveyor must first push the immersed tray into engagement with the exit conveyor belt. This design was used to eliminate the possibility of a tray bridging the two belt systems (one tray engaged with both belts). Once a tray is engaged with the exit conveyor belt, the tray continues along the belt until its position under the chiller hood is detected by a limit switch. The food tray remains under the chiller hood, which blows 20°F air over the food product to bring it from process temperature down to ambient. On the next cycle the belt pushes the cooled tray out of the hood and onto a slide rack which provides a stack up area for the trays to accumulate. The operator must remove the food tray after each cycle or the second tray will trip a limit switch and stop the unit before a food tray can be dropped on the floor. The slide rack assembly is identical to the wire belt support, but has no belt over it. Aside from the chiller hood and the slide rack, the exit conveyor is the same as the entrance unit, as discussed previously.

2.3.3 Conveyor Components: A DC variable speed unit was chosen as the conveyor belt drive to allow the belt speeds to be optimally adjusted. Bearings in this system are either a high molecular weight polyethylene (HMP) bushings that require no lubrication or a double sealed ball bearing unit that is lubricated with food safe grease. The flexible wire belt supports the tray weight by sliding across three HMP belt support rails. To ensure proper alignment of the food trays for engagement with the vacuum chamber tray cradle, there are two food tray guides. The guides have a tapered leading edge and then a straight section to hold the tray steady while it is pushed onto the cradle assembly. Each food tray has four tabs which engage the wire belt as shown in Figure 8. These tabs allow the belt to positively push the trays along and limit the angular misalignment that a tray can have as it engages the tray cradle.

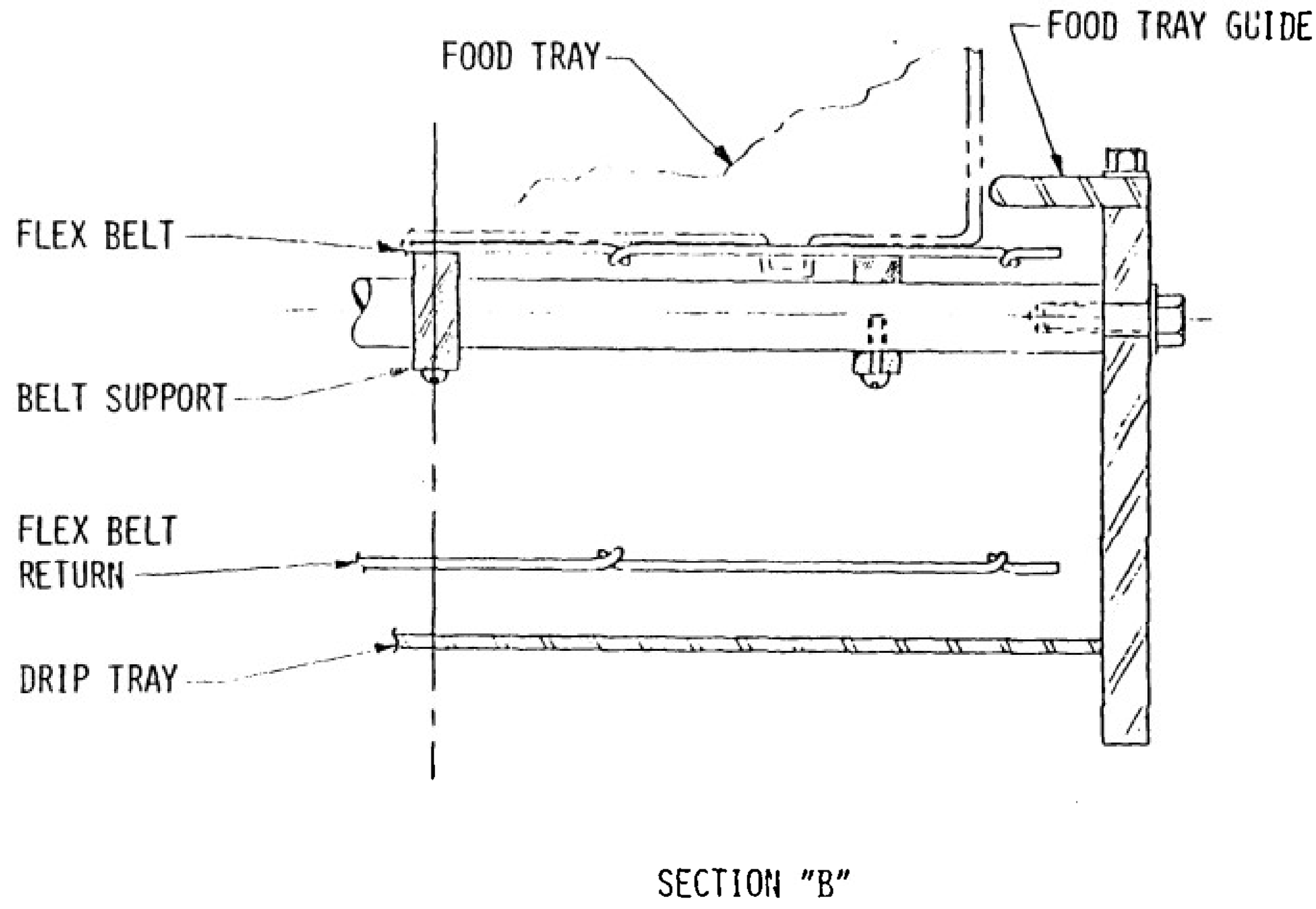

Figure 8. — Conveyor Belt Detail.

To properly center the food tray within the immersion dish a limit switch, located on the conveyor base plate, contacts an adjustable striker mounted on the conveyor leg.

2.3.4 Conveyor Belt Cleaning: While the wire belt motor is in motion the belt return portion is being cleaned by a series of steam jets which spray both sides of the belt. Dislodged material is collected in a catch basin and goes to the sanitary floor drain. A steam deflector collects steam vapors and ducts them out of the steam bath area and through a vent hole to prevent the food trays loaded on the conveyor from absorbing the water vapors (see Figure 9). The bottom side of the conveyor is enclosed with a drip tray, which will prevent food particles from falling on the floor.

2.4 Process Air (See Figure 6 and Drawing D12555): The lipoidal liquid infusion cycle uses process air in two stages of the system cycle, first to remove excess liquid from the infused food product after immersion, then to cool the food product from the processing temperature down to room ambient.

2.4.1 Warm Air System: To provide warm air, room air enters the system blower and is warmed by a steam-to-air heat exchanger. Next the air is filtered to food use quality and piped to the warm air manifold for removing excess liquid from the food product. At this point in the overall system cycle, the vacuum chamber door closure cylinders have been deenergized allowing the process air blower to crack open the chamber doors and vent the warm process air back into the room.

The process air blower develops 5 inches of water pressure, while delivering 300 cubic feet per minute of air. This rate will provide an adequate air velocity at the manifold slots to blow the process air through the stacked food product in the tray. The steam to air heat exchanger is a single row finned galvanized steel core.

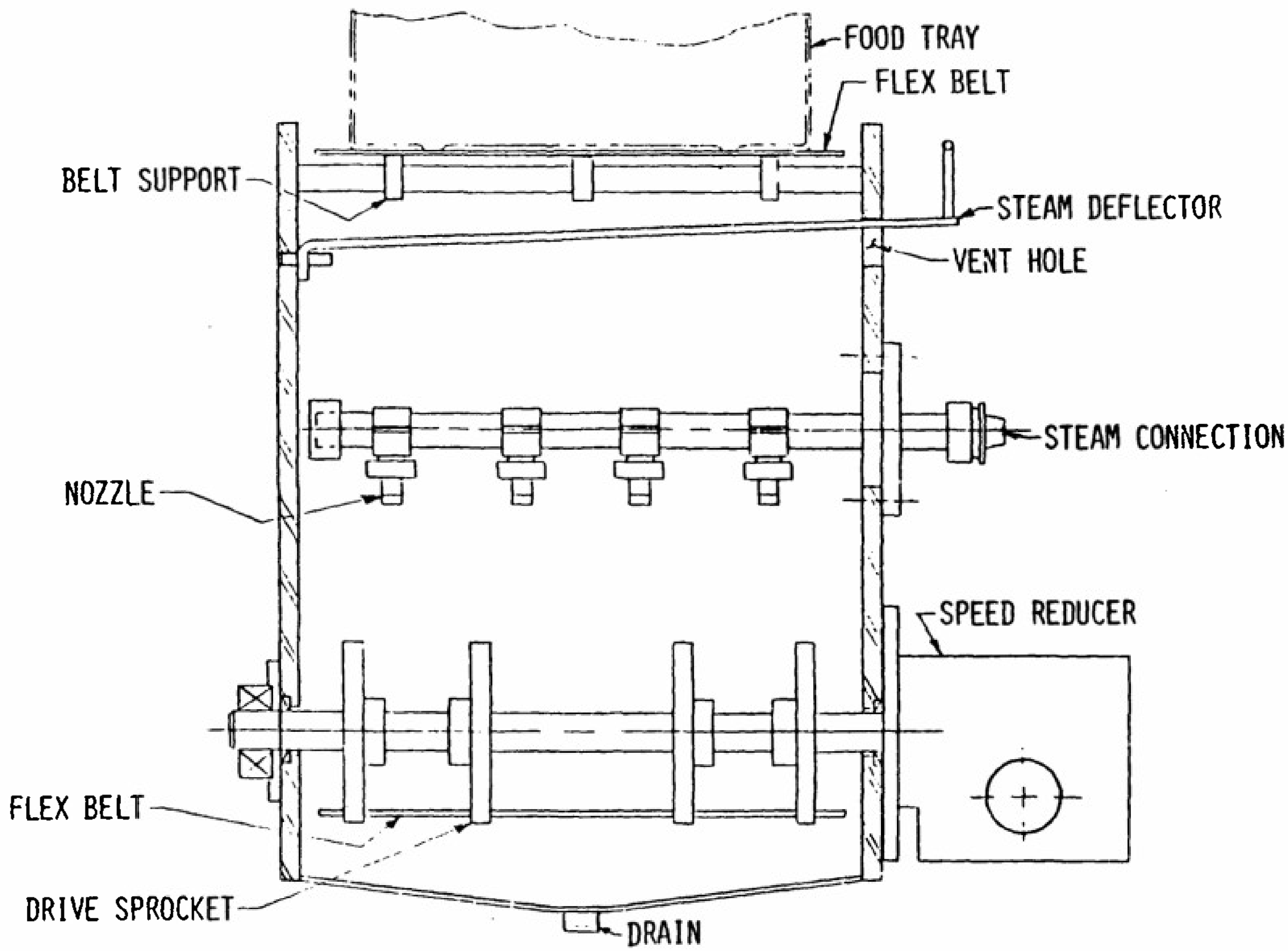

Figure 9. — Conveyor Drive Detail.

A thermostatically controlled steam throttling valve is used to control the process air temperature, with the thermostatic bulb placed just upstream of the filter unit to obtain a mixed air temperature. The steam supply is reduced by a regulating valve from the 90 psi main to 5 psi for use in the coil. The coil performance can be improved by raising this regulated steam pressure, if needed. Air temperatures approaching those of the steam are possible due to the large coil size. The coil size was designed to match the filter duct size available, which eliminates additional transition pieces and makes a compact unit. The air filter provides 99.9+ percent removal of airborn particulate matter and is suitable for clean room or sanitary use. The air duct transitions after the filter down to the 3" pipe size for the vacuum chamber penetration. A 3" butterfly vacuum valve provides the sealing needed during the vacuum process and minimal restriction when the process air is required.

2.4.2 <u>Chilled Air:</u> To provide chilled process air room air enters the system blower and is driven through an evaporator coil. The chilled air is filtered and ducted to the chiller hood to cool the infused food product from the processing temperature of up to 150° F down to 60°F. The cool air vents out the hood into the room. For added efficiency a second flexible duct can be added to the tray inlet side of the chiller hood to recycle the chilled air. Given the low density food products envisioned for this system, the lower hood temperatures were not considered necessary at this time.

The evaporator coil receives freon from a packaged refrigeration unit with built-in controls. A thermostatic bulb mounted in the coil duct will provide the refrigeration unit with its temperature feedback. A second set of refrigerant lines supplies the vacuum trap with coolant (a needle valve in the trap's liquid supply line will control coolant flow through the trap coil). Identical air filter units will be used in warm and chilled air supplies to simplify filter replacement. A flexible 6" duct connects the air transition from the filter to the chiller hood.

The air handling unit is located over the midpoint of the exit conveyor travel to minimize hose travel. The chiller hood is designed to split the air flow and ensure cold air flows across the top and bottom surfaces of the infused food.

3.0 ELECTRICAL SYSTEMS

The design for the electrical system is based on the criteria outlined in Figure 1. The primary control element of the vacuum infusion system is a microprocessor-based programmable logic controller. The programmable logic controller performs the task of sequential operations when in automatic mode and maintains interlock control over the discrete and analog inputs and outputs required to run the system in manual mode.The operator control console (Figure 10) serves as the central interface point for all control operations. The control console provides the operator with the switches for device activation as well as displays for monitoring system process variables (i.e. pressure, temperature, and liquid level). The control console functions as the power distribution center for all the motors, pumps, blowers, and valve actuators.

3.1 Operating Modes

The vacuum infusion system utilizes two operating modes, manual and automatic. When the system is turned on,it immediately defaults to manual mode. All displays are energized as well as the indicators that represent current device positions. In manual mode the operator has direct control over the entire process cycle. Input commands from the operator are checked against interlock conditions to prevent the possibility of operating devices out of the necessary safety sequence. Prior to selecting automatic mode, the operator must accomplish the following:

1. Energize the hot water pump and steam supply system
2. Fill the reservoir with lipoidal liquid
3. Energize the recirculation pump
4. Adjust temperature setpoints
5. Adjust liquid level setpoint
6. Verify all components are operational
7. Allow the system sufficient time to reach setpoint

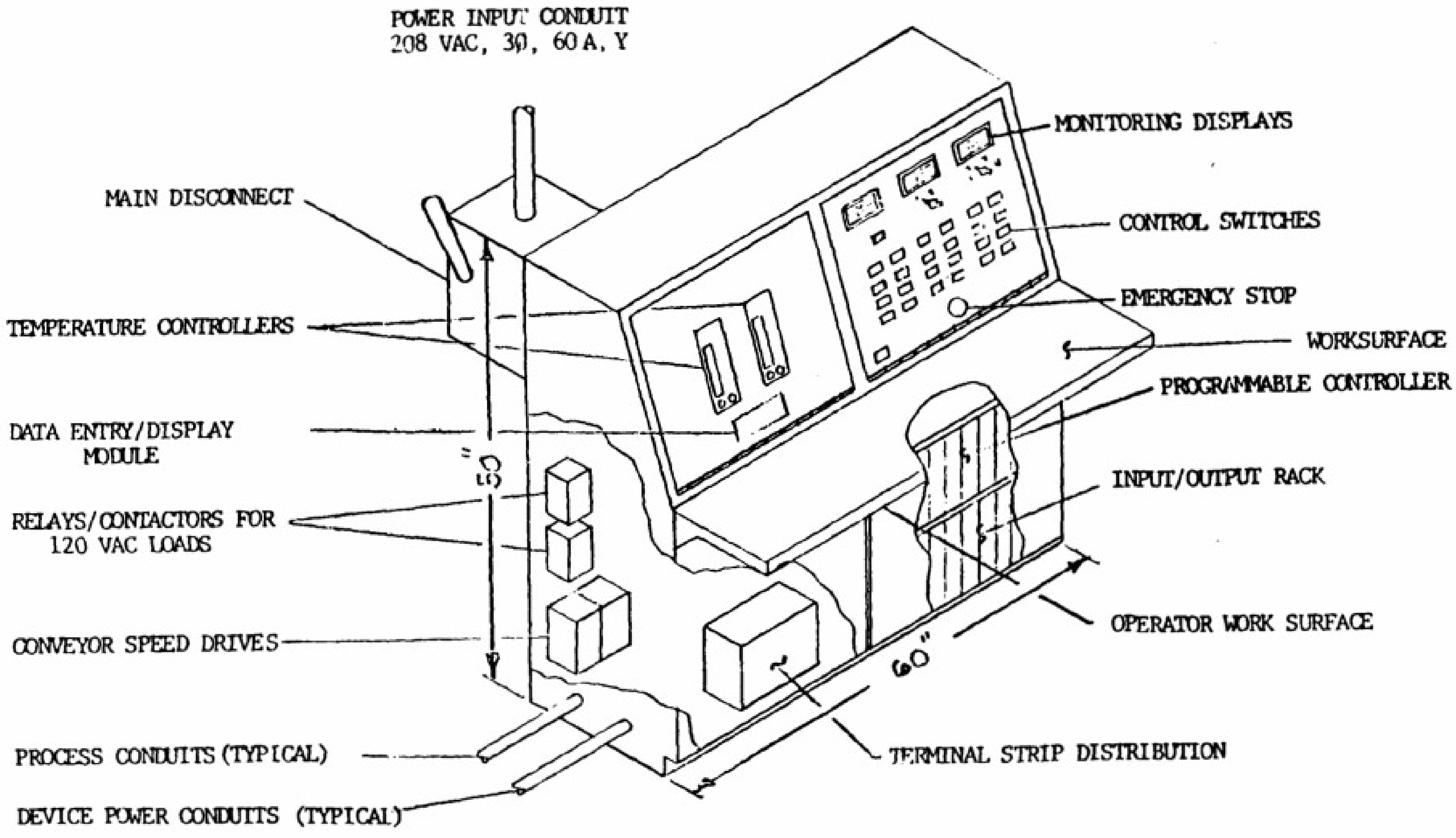

Figure 10. — Operator Console Assembly.

The automatic mode enables the programmable controller to have direct control over the complete process cycle. The device switches available to the operator in manual mode are nonfunctional when operating in automatic mode. However, temperature and liquid level setpoints remain operator adjustable at all times.

Once automatic mode is selected, the operator initiates the process cycle by selecting the START sequence switch. The two main responsibilities of the operator from this point are: 1) load trays on the entrance conveyor, and 2) pick up trays as they come off the exit conveyor, 3) ensure sufficient lipoidal liquid is available in the reservoir.

An exit conveyor limit switch has been provided to prevent trays from jamming or dropping food on the floor. If a tray is left on the exit conveyor table, the next tray to come off the conveyor belt will push the previous tray into a limit switch and all operations will be suspended until the operator removes the trays from the exit conveyor table and resets the system from the control console. Critical process cycle times will not be extended, but operation will stop when timer functions are satisfied.

3.1.1 Safety Considerations

Emergency stop switches are provided at three locations; the operator control console, the vacuum chamber, and the exit conveyor. Activation of an emergency stop from any of these three locations will result in loss of power to all field devices (i.e. motors, pumps, blowers, and valves). The chamber doors, conveyor tables, and tray carriage remain stationary when power is removed. When the emergency stop condition is activated an alarm on the control console will sound and operation will be transferred to manual mode. Once the operator has corrected the situation that caused the emergency stop, normal operations can be resumed by pressing the Reset switch on the operator control console (Reference Figure 11).

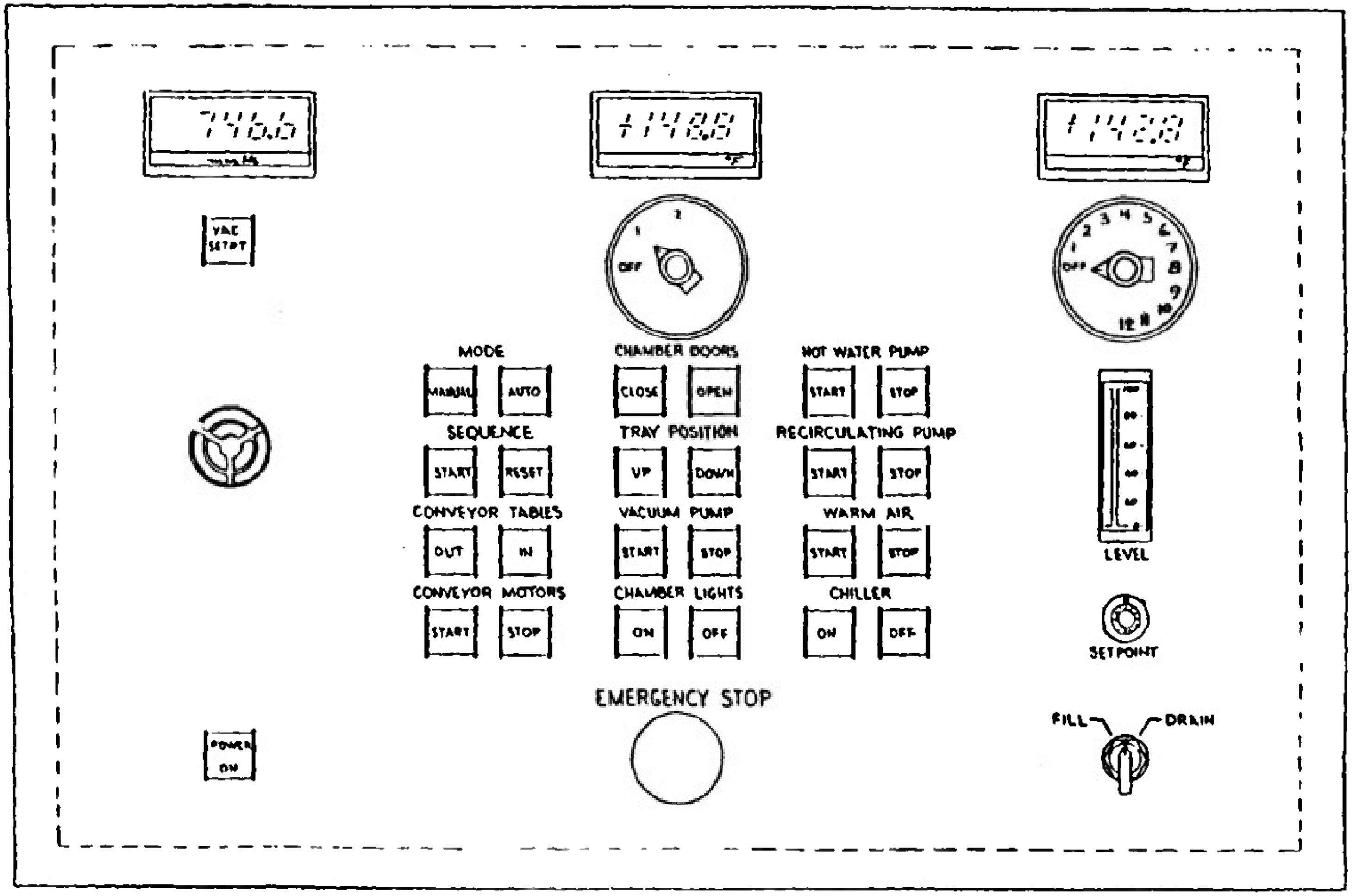

Figure 11. — Operator Panel.

3.2 Process Control Loops

The control system has three independent process control loops, the lipoidal liquid temperature, the lipoidal liquid level, and the chamber vacuum level.

The two separate temperature control functions of the liquid in the reservoir and the immersion dish is performed by two single loop, proportional-integral-derivative (PID) controllers. Each controller is capable of controlling over an operational range from ambient to 175°F with an accuracy of ±1.4°F. The thermocouples in the reservoir and immersion dish are used by their respective controllers to regulate the control valve to achieve the desired setpoint. Each temperature controller has an adjustable setpoint alarm output for high temperature or open thermocouple conditions.

The liquid level process loop for the immersion dish is controlled to an operator adjustable setpoint entered from the control console. The liquid level setpoint command is based on a percentage of the maximum fill point of the immersion dish. The operator can manually operate the fill/drain pump from the control console. The pump will automatically stop on the fill cycle when the setpoint level is reached. During the drain cycle, liquid level will be monitored as the liquid is pumped out. The sensor will indicate a zero level when the liquid reaches the conical section of the dish. A timer will then allow continued operation of the drain cycle pump until the dish and pipe are empty but without aerating the lipoidal liquid. An LED bar graph display on the control panel provides a continuous display of the liquid level.

The chamber vacuum level is controlled automatically by a vacuum setpoint controller and modulating vacuum valve. Once the vacuum pump has been turned on, the controller uses a vacuum transducer/transmitter in the chamber to monitor the level of vacuum. The vacuum level transmitter also drives a display on the control panel, providing the operator with visual indication in engineering units of the chamber vacuum level. The vacuum level signal is also connected to the programmable logic controller for monitoring and setpoint comparison status. The vacuum pump runs continuously throughout the infusion process.

Once the setpoint is reached, the vacuum level is held by the modulating control valve. The VAC SETPT indicator on the control panel is energized when the vacuum level setpoint is reached, and the next cycle step is initiated.

3.3 Sensor Considerations

A key element of the control system is the sensors used for detecting system state changes. Sensors have been appropriately selected for monitoring temperature, vacuum level, liquid level, device movements, and water flow.

The temperature sensors selected are Type T thermocouples, these will be used for all process control signals as well as noncritical monitoring points.

An absolute pressure transducer provides continuous feedback of chamber vacuum level. This signal is used to provide continuous indication at the control console as well as close loop control on the vacuum pump isolation valve (V1). An analog roughing gauge is mounted on the chamber for local indication of the chamber vacuum level.

The liquid level sensor in the immersion dish is an ultrasonic type that provides continuous feedback of the liquid level from 0 to 6-½ inches. The sensor is used to provide continuous indication, as well as control information for the fill/drain pump operation.

The ability to detect the movements and positions of various devices is critical to the sequential operation of the system. Lever actuated limit switches are precisely located to sense the position of the chamber doors, conveyor tables, product trays, and specific valves. Adequate adjustment capability has been designed in for easy set up of switch actuation points.

The water used for cooling the vacuum pump is monitored by a flow switch interlock. The flow switch is a snap action paddle type.

3.4 **Drive Motors & Valve Actuators**

The drive motors for the conveyor belts are variable speed DC motors. The operator can adjust the belt speed for each conveyor from the motor drive located inside the control console.

The motors for the various pumps and blowers are squirrel-cage induction type. Drawing D12566 shows the motors used in the system and their power requirements. Motors 1/2 hp and smaller were selected to operate on 208-volt, single-phase, 60-cycle circuits. Motors larger than 1/2 hp were selected to operate on 208-volt, three-phase, 60-cycle circuits. This best utilizes the efficiencies and current requirements of available motors. Motor starters used with all motors are full-voltage, across the line, with integral thermal overloads.

The pneumatic actuators for the system are controlled by electrically operated solenoid air valves. The solenoids operate from 115-volt, single-phase, 60-cycle circuits.

3.5 **Operational Summary**

The following operational summary assumes that the system is adequately sterilized, that all components are operational, that the conveyor tables are retracted away from the chamber, and the chamber doors and connecting valves are closed. Refer to Figure 11 for switch layout on the operator panel.

> **NOTE:** At any point during the cycle, in either automatic or manual mode, the operator can immediately stop the system by pressing any of the three EMERGENCY STOP switches.

1. Turn the power on by pressing the POWER switch on the control panel at the operator console.
   - the audible alarm will sound, the operator should press the RESET switch to clear the system
   - the digital displays should energize and show values reflective of the current system status
   - system operations default to manual mode

- the switch indicator lights show the current position and state of each device in the system.

2. Verify the reservoir has an adequate supply of liquid for operation, fill as required.

3. Manual mode operations:

   - start the hot water pump by pressing the corresponding START switch

   - enter the temperature setpoints on the temperature controller as per manufacturer's instructions.

   - start the recirculation pump by pressing the corresponding START switch

   - start the vacuum pump by pressing the corresponding START switch.

   - enter the immersion dish liquid level setpoint by adjusting the level select dial to the desired percent of full (0-100%)

   - start the chiller by pressing the corresponding START switch

4. Allow sufficient time for the temperature of the liquid in the reservoir to achieve the setpoint. The temperature can be continuously monitored on the displays. Each of the temperature displays has a selector switch associated with it. The process display has a two-position switch, and the monitor display has a five position switch. Table 1 lists the temperature data displayed for each switch selection.

TABLE 1

Temperature Displays

Device	Switch Setting	Data
Process Display	1	Immersion Dish Infusion Liquid
Process Display	2	Reservoir Infusion Liquid
Monitor Display	1	Circulating hot water
Monitor Display	2	Ambient inside Vacuum Chamber
Monitor Display	3	Cold air
Monitor Display	4	Warm air
Monitor Display	5 to 12	Spares

5. Prior to starting the cycle, the operator should load product trays on the entrance conveyor, the first tray should be positioned such that it actuates the entrance limit switch. Subsequent trays should be positioned with a minimum of six-inch spacing between trays.

6. Manual sequential operations:

   a. Open the chamber doors by pressing the chamber door OPEN switch.

   b. Cycle the conveyor tables in by pressing the conveyor table IN switch.

   c. Cycle the product tray into the chamber by pressing the conveyor motor ON switch. The steam bath for each conveyor belt will be energized while the belt is moving - the entrance conveyor belt will stop automatically when the next product tray moves to the end of the belt. The exit conveyor belt stops when the product tray is positioned under the chiller hood. If desired both belts can be stopped by pressing the conveyor motor OFF switch.

   d. Retract the conveyor tables by pressing the conveyor table OUT switch.

   e. Close the chamber doors by pressing the chamber door CLOSE switch.

   f. Lower the product tray by pressing the tray position DOWN switch.

   g. Start the vacuum cycle by pressing VAC SETPOINT switch. This opens the isolation valve between the pump and the chamber.

      - Monitor the vacuum level through the display, when the setpoint is reached the VAC SETPT indicator will light.

      - When the setpoint is reached the isolation valve will modulate to maintain setpoint. Keep the vacuum pump running at all times.

      - The operator can stop the vacuum pump at any point by pressing the STOP switch.

   h. Fill the immersion dish to the selected setpoint level by holding the FILL/DRAIN switch in the FILL position. The LED display provides an indication of the liquid level in the dish.

      - the fill/drain pump and the isolation valve operate automatically when the switch is selected.

      - a high level override will automatically de-energize the pump and close the valve if a preset high level limit value is reached.

i. The dwell time measurement is started when the level setpoint is reached. The dwell period is operator adjustable from the Timer Display Module. The operator can raise the tray at any point before the dwell time cycle completes by pressing the tray position Up switch.

- When the time period is completed the vacuum is released by vacuum break valve.

- The product tray is raised from the liquid and permitted to drain into the immersion dish.

- The tray may be shaken after it has been removed from the liquid. This feature promotes the removal of excess liquid from the food and tray. Shake time is adjustable from zero up to the required time period.

- Empty the immersion dish by holding the FILL/DRAIN switch in the DRAIN position - the fill/drain pump and the isolation valve will automatically de-energize when the immersion dish is empty.

- Open the warm air valve and start the blower by pressing the warm air ON switch.

- The blower will assist in removal of excess liquid from the product trays as the trays cycle out.

- Remove the processed food tray by the conveyor and operate conveyor until tray is positioned under chiller hood.

j. Repeat steps b through i.

The steps outlined in the previous sections are described as manual mode operation. These steps will be automatically and sequentially performed in auto mode. Select auto mode by pressing the AUTO switch on the control panel. The operator's primary responsibility in auto mode will be loading and removal of the product trays.

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APPENDIX A

COMPONENT SPECIFICATIONS

COMPONENT SPECIFICATIONS

General

Proof of conformance with contract code requirements: Where materials or equipment are specified to conform to requirements of the Underwriters Laboratories, Inc., or the Factory Mutual System, the Contractor shall submit proof of such conformance. The label or listing of the specified agency will be acceptable evidence. In lieu of the label or listing, the Contractor may submit a written certificate, from any approved nationally recognized testing organization adequately equipped and competent to perform such service, stating that the items have been tested and that the units conform to the requirements, including methods of testing, of the specified agency. Where equipment is specified to conform to requirements of the ASME Boiler and Pressure Vessel Code, the design, fabrication, and installation shall conform to the code in every respect, except that code stamping is not required

- Method of Construction: As much as practical, equipment shall be mounted on a minimum number of bases to facilitate site installation and relocation at a later date. All utilities and service lines shall terminate at one general location of the completed unit to facilitate hook up after installation.
- Workmanship: Workmanship shall be of the highest grade throughout and in accordance with the best standard practice for this type of equipment. Castings and other parts shall fit accurately and shall be tight where necessary. In joint pieces of similar metal, fastening devices and metal used for welding shall be of the same material as the metal being joined. When corrosion-resisting steel is joined to dissimilar metal, fastening devices and metal used for welding shall be corrosion-resisting steel. Chromium plating, where used, shall be applied over nickel plating.

- Nameplates: Each major item of equipment shall have the manufacturer's name, address, and catalog number on a plate securely attached to the item.

- Safety Requirements: Belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts shall be fully enclosed or properly guarded. High-temperature equipment and piping so located as to endanger personnel or create a fire hazard shall be properly guarded or covered with insulation of a type as specified.

- Verification of Dimensions: The contract drawings show the extent and general arrangement of the vacuum infusion system. The Contractor shall visit the premises to be thoroughly familiar with all details of the work and working conditions. Final arrangement shall be to suit actual site installation area.

- Coordination of Trades: The Contractor shall be specifically responsible for the coordination and proper relation of his/her work to the building structure and to the work of all trades.

- Materials: Materials and Equipment shall conform to the respective publications and other requirements specified below. Other materials and equipment shall be as specified elsewhere herein and as shown, and shall be the products of manufacturers regularly engaged in such manufacture. Items of equipment shall essentially duplicate equipment that has been in satisfactory use at least two years prior to bid opening and shall be supported by a service organization.

Welding

Welding shall be done in a thorough manner with welding rod of compatible composition with the sheets or parts to be welded. Welds shall be strong and ductile, with excess metal on exposed working surfaces ground off and joints finished smooth to match adjoining surfaces. Welds shall be free of imperfections such as pits, runs, spatter, and cracks, and shall have the same color as the adjoining surfaces. Joints shall be welded by some process other than by carbon-arc welding or any process that permits carbon pickup. Butt welds made by welding straps under seams, by filling in with solder, and by grinding, will not be acceptable. Welded joints shall be homogeneous with the sheet metal. In no case shall spot welding be substituted for full welding. Where sheet sizes necessitate a joint, such joint shall be welded.

Vacuum Chamber

- Design and fabricate in accordance with ASME Pressure Vessel Code Section VIII, Division I.
- Operating Pressure: 1 torr to 20 psig.
- Operating Temperature: 60° to 150°F.
- Door hinge assembly shall be designed to provide 2 psi minimum force on door seal with 100 psig air supply cylinders.
- For additional details reference drawing D12557.

Food Tray Conveyor:

- Maximum loading of (3) three trays (each 24" x 12") at 10 lbs. (5 lbs./sq.ft.) each.
- Variable speed D.C. motor with speed reducer to provide belt speed of 0 to 30 feet per minute.
- All components used shall be rated for washdown use.
- All materials contacting the food product shall be compatible with all applicable food service requirements.
- For additional details reference drawings D12559 and D12560.

Immersion Dish and Reservoir:

- Hot water heated embossed jacket. Maximum Product Temperature - 150°F
- Support attachments to withstand weight of liquid (62 lb./ft.^{3}) with components completely full.
- All internal surfaces of component and sanitary type connections shall have a No. 4 finish or better.
- For additional details reference drawing D12562.

System Piping Description

- Lipoidal Liquid System:

  Operating Condition 100 psig @ 150°F max.

  Tubing - Stainless steel 316, rnonpolished O.D., polished I.D.

  Fittings - Stainless steel 316 3A rated, sanitary O-ring/clamp, polished, Swage type.

- Vacuum System:

  Operating Condition - Full vacuum

  Pipe - Carbon steel, SCH 40, ASTM A-53 GR B, and ANSI B36.10

  Fittings - Carbon steel standard weight seamless, ASTM A-403 and ANSI B16.9

  Flanges - Carbon steel, 150 lb. ASTM A-53 GR II, and ANSI B16.5

  Gasket - "GORE-TEX" Teflon Cord

  Flange Bolting - Alloy steel ASTM A-193, GR B7

- Steam System:

  NOTE: See drawings for exception.

  Operating Conditions - 90 psig @ 330°F
  5 psig @ 230°F

  Pipe - Carbon steel furnace buttweld SCH 40 steam, SCH 80 condensate ASTM A-53 GR B and ANSI B36.10.

  Fittings - 2000 or 3000 PSI WOG to match pipe wall, carbon steel forged, socket weld or NPT ends, ASTM A-105 and ANSI B16.11.

  Flanges - Carbon steel forged 150 lb. ASTM A-105 GR II and ANSI B16.5.

  Gaskets - Compressed asbestos sheet, ASMT F104, Type I - P1161A, graphite coated, self centering.

Flange Bolting - Steel, hex bolts, ASTM A-307, heavy hex nuts ANSI B18.2.2.

Pipe Thread Compound - TFE tape, 2 mil thick minimum

Insulation - 1-1/2" thick fiberglass suitable for temperature range, polyvinyl chloride protective covering. All except stainless steel rotation assembly.

- Hot Water System

Operating Conditions 50 psig @ 250°F max.

Tubing - Copper, Federal Specification WW-T-99, Type K or L

Fittings - Wrought copper or brass solder joint pressure ASTM B-75 and ANSI B15.22, cast bronze solder joint pressure ANSI B16.18.

Solder - Silver, Federal Specificaton QQ-B-654

Insulation - 3/4" thick fiberglass suitable for temperature range, polyvinyl chloride protective covering.

- Water and Drain System:

Operating Condition - 40 psig @ 60°F

Tubing - Copper, Federal Specification WW-T-99, Type K or L

Fittings - Wrought copper or brass solder joint pressure ASTM B-75 and ANSI B16.22, cast bronze solder joint pressure ANSI B16.18

Solder - Silver, Federal Specification QQ-B-654

Insulation - 3/4" thick closed cell, elastomeric on water line only.

- Control Air:

Operating Conditions - 100 psig max.

Tubing - Copper annealed seamless ASTM B-280.

Fittings - Ball sleeve compression, brass SAE J-512

- Refrigerant System:

Operating Condition -

Fittings - Wrought copper or brass solder, joint pressure ASTM B-75 and ANSI B16.22, cast bronze solder joint pressure ANSI B16.18

Solder - Silver, Federal Specification QQ-B-654

Insulation - 3/4" thick closed cell; elastomeric on "cold" line only.

- <u>Warm and Chilled Air:</u>

  Operating Conditions - Warm: 300 cfm @ 5" S.P. @ 150^{o}F
  Chilled: 800 cfm @ 6" S.P. @ 20^{o}F

  Pipe - Carbon steel, SCH 40 ASTM A-53 GR B, and ANSI B36.10

  Fittings - Carbon steel, standard weight ASTM A-105 GR II, and ANSI B16.11

  Flanges - Carbon steel, 150 lb. ASTM A-105 GR II, and ANSI B16.5

  Gasket - "GORE-TEX"

  Flange Bolting - Alloy steel ASTM A-193, GR B7

APPENDIX B

BILL OF MATERIAL

BILL OF MATERIAL

Mechanical Systems

Equipment Item	Quantity	Manufacturer	Suggested Description
AV1 Valve Air Eliminator	As Required	McMaster-Carr	3/4" Male NPT # 4928K4
B1, B2, Blowers, Chilled Air, Warm Air	2	Zurn Clarage	300 cfm, Model AAR.4 Model AAR.4 Size 6-SS with 1-1/2 HP, 3480 RPM, 208V AC - 60 Hz 30 Motor
C1, Coil, Chilled Air	1	Coil Co., Inc.	DS Coil 12" x 15" - 2 row, 3/8" dia. tube, 8 fins/inch.
C2, Coil, Warm Air	1	Coil Co., Inc.	Steam Coil, 18" x 18" - 1 row, 5/8" dia. tube, 12 fins/inch.
ET, 1 Expansion Tank	1	Bell & Gosset	15 gal - ASME Rated Model #15
F1, Filter	1	Ladish	150 psi Model FM1 - 1-1/2-44M with S1 - 1-1/2 - 09 support tube
F2, Filter, Warm Air	1	American Air Filter	B10-CEL BF-2424-12AM with Astro-seal 2H housing
F3, Filter, Chilled Air	1	American Air Filter	Same as F2
F4, Filter, Control Air	1	Master Pneumatic	1/2" Automatic Drain Detroit Model FD100 - 4 -E3

Equipment Item	Quantity	Suggested Manufacturer	Description
G1, Gauge, Hot Water	1	Wika	0-30 PSI, 2-1/2" face bronze, Model 213 1/4" bottom
G2, Gauge, Vacuum	1	Wika	Compound 30-0-15" Hg 4" face, SST Model 232-G 1/4" bottom
G3, Gauge, Steam	1	Wika	0-150 PSI, 2-1/2" face, Bronze Model 213, 1/4" bottom
G4, Gauge, Steam	1	Wika	0-15 PSI, 2-1/2" face, Bronze Model 213
H1, Hose, Vacuum and Warm Air	2	Kinney	3" - 150# Flanged Model 202032
H2, Hose, Chilled Air	1	McMaster-Carr	6" I.D. x 66" long (est) Model 5497K76
H3, Hose, Steam Bath Drain	1	Gates	1-1/2" I.D. x 6'-0" long (est) Model 75W
H4, Hose, Steam Bath Drain	1	Gates	1-1/2" I.D. x 7'-0" long (est) Model 75W
H5, Hose, Steam Washdown	1	Gates	1/2" I.D. x 40' long (est) Model 12B
H6, Hose, Washdown Suction	1	Gates	1/2" I.D. x 10'-0" long (est) Model 12B
H7, Hose, Air Line	4	Gates	3/8" I.D. x 4'-0" long Model 19B
HE1, Heat Exchanger	1	Bell & Gosset	Type "SU" steam to liquid Unit Number SU 64-4
Immersion Dish	1	Tranter	Model JA, modified per detail drawing D12562
L1, Lubricator, Control Air	1	Master Pneumatic Detroit	Capillary Feed Model L100 - 4 - Q
P1, Pump, Vacuum	1	Kinney	Model KDH - 150 with 7-1/2 HP, 1750 RPM 208/3/60 Motor
P2, Pump, Immersion Dish Fill/Drain	1	M/D Pneumatics	2" 20 GPM 20 PSIG Model S4/6 - 120

Equipment Item	Quantity	Suggested Manufacturer	Description
P2, Pump, (cont.)	1	Lovejoy	Coupling 3/4 x 1 Model L-190
	1	Boston	Reducer 6.3:1 Model F622-6.3-B7
	1	Boston	2 HP 1750 RPM 208/3/60 Motor Model KUTF-C
P3, Pump, Oil Recirculation	1	M/D Pneumatics	1-1/2" 5 GPM 90 PSIG, Model S 4/6-110
	1	Lovejoy	Coupling 3/4" x 1" Model L-225
	1	Boston	Reducer 8:1 Model F632-8-B9
	1	Boston	3 HP 1750 RPM 208/3/60 Motor Model LUTF
P4, Pump Hot Water	1	Bell & Gosset	Inline Booster Pump 25 GPM 9 PSIG Model PD 35S, Bronze Body with 1/2 HP 1750 RPM 208/1/60 Motor
P5, Pump, Condensing Unit	1	Bally	1/2 HP 4880 Btu/hr @ 25^{0} evaporating temp. Model FRAM-0050
Reservoir	1	Tranter	Model JA, modified per detail drawing.
RV-1, Relief Valve, Hot Water	1	Bell & Gossett	1", 75 PSIG setting ASME rated, 1170-75
RV-2, Relief Valve, Steam	1	Bell & Gossett	1" x 1", 100 PSIG setting, ASME rated, 1170-100
RV-3, Relief Valve, Steam	1	Bell & Gossett	1" x 1-1/4", 15 PSIG setting, ASME rated, Model 750-15
S1, Strainer	1	Yarway	1", Y-Type, Model 901
S2, Strainer	1	Yarway	1", Y-Type, Model 901

Equipment Item	Quantity	Suggested Manufacturer	Description
S3, Strainer	1	Yarway	1", Y-Type, Model 901
S4, Strainer	1	Yarway	1", Y-Type, Model 901
S5, Strainer	1	Yarway	1-1/2", Y-Type, Model 901
S6, Strainer	1	Yarway	1", Y-Type, Model 901
SSM1, Steam/Soap Mixer	1	McMaster-Carr	3/4" with 6' suction hose and 5' wand Model 3157K1
T1, Trap Steam	1	Armstrong	1" Float and Thermostatic, Model 125-A4
T2, Trap Steam	1	Armstrong	1" Float and Thermostatic, Model 125-A4
T3, Trap Steam	1	Armstrong	1" Float and Thermostatic, Model 125-A4
T4, Trap Steam	1	Armstrong	1" Float and Thermostatic, Model 125-A6
T5, Trap Steam	1	Armstrong	1" Float and Thermostatic, Model 125-A6
T6, Trap Steam	1	Armstrong	1-1/2" Float and Thermostatic, Model 125-A6
T7, Trap Steam	1	Armstrong	1" Float and Thermostatic, Model 125-A4
T8, Trap, Vacuum	1	Varian	4" Model 0334-F8286-304
V1, Valve, Vacuum	1	Fisher	3" ball valve with TCM seals, size 3D, 1051 actuator, unit to fail open, for vacuum service, Fisher valve number 3"-1051-V100-36103-546

Equipment Item	Quantity	Suggested Manufacturer	Description
V2, Valve, Oil Fill/Drain	1	Ladish Tri-Clover	4" with fail open actuator, Model 161-10-A10-4-Fig.1
V3, Valve, Warm Air	1	Kinney	3" with fail open actuator, Model 900293
V4, Valve, Hot Water	1	Asco	1" bronze globe valve, to fail open with full ported trim and size 3D actuator, Model No. 1-657-GS-3590
V5, Valve, Steam Control	1	Asco	1" globe valve with 1/2" equal percentage trim, to fail closed, size 3D actuator, Model No. 1"-667-E2-3590
V6, Valve, Steam Shutoff	1	Asco	1-1/2" normally closed 8222B82
V7, Valve, Air Control	1	Numatics	1/4" side ports, Model 120SA5410A
V8, Valve, Air Control	1	Numatics	1/4" side ports Model 12DSA6410A
V9, Valve,	1	Numatics	1/4" side ports Model 12DSA6410A
V10, Valve,	1	Numatics	1/4" side ports Model 12DSA4410A
V11, Valve, Air Shutoff	1	Worcester	1/2" with fail close solenoid/penumatic actuator Model A4[illegible]3VSE-S-M2-115/60
V12, Valve,	1	Lunkenheimer	1/2" Model Fig. 2140
V13, Valve, Oil Drain	1	Ladish Tri-Clover	1-1/2" Model D60YRMP
V14, Valve, Oil Recirc.	1	Ladish Tri-Clover	1-1/2" Model D60TRMP

Equipment Item	Quantity	Suggested Manufacturer	Description
V15, Valve, Water Shutoff	1	Lunkenheimer	3/4" Model Fig. 2140
V16, Valve, Water Check	1	Lunkenheimer	3/4" Model Fig. 2144
V17, Valve, Hot Water	7	Lunkenheimer	1" Model Fig. 2140
V18, Valve, Steam Control	1	Asco	1" normally closed Model 822026
V19, Valve, Steam Shutoff	1	Lunkenheimer	1" normally closed Model 2140
V20, Valve, Steam Control	1	Danfoss	3/4" with thermostat & capilliary sensor, Model Bravo Hi-Head
V21, Valve, Steam Shutoff	1	Lunkenheimer	1" normally closed Model 2140
V22, Valve, Steam Control	1	Asco	1" normally closed Model 822026
V23, Valve, Oil Drain	1	Ladish Tri-Clover	2" Model D60YRMP
V24, Valve, Oil Drain	1	Ladish Tri-Clover	1-1/2" Model D60YRMP
V25, Valve, Air Regulator	1	Master Pneumatic Detroit	1/2" with gauge Model R100-4 with 200-BDD Gauge
V26, Valve, Air Regulator	1	Master Pneumatic Detroit	1-1/2" with gauge Model R100-4 with 60-BDD Gauge
V27, Valve, Water Shutoff	1	Lunkenheimer	3/4" with gauge Model Fig. 2140
V28, Valve, Speed Control/Muffler	1	Arrow Pneumatics	1/4" Sintered Bronze Model ASP-2SC
V29, Valve, Speed Control/Muffler	1	Arrow Pneumatics	1/4" Sintered Bronze Model ASP-2SC
V30, Valve, Speed Control/Muffler	1	Arrow Pneumatics	1/4" Sintered Bronze Model ASP-2SC
V31, Valve, Speed Control/Muffler	1	Arrow Pneumatics	1/4" Sintered Bronze Model ASP-2SC

Equipment Item	Quantity	Suggested Manufacturer	Description
V32, Valve, Speed Control/Muffler	1	Arrow Pneumatics	1/4" Sintered Bronze Model ASP-2SC
V33, Valve, Speed Control/Muffler	1	Arrow Pneumatics	1/4" Sintered Bronze Model ASP-2SC
V34, Valve, Speed Control/Muffler	1	Arrow Pneumatics	1/4" Sintered Bronze Model ASP-2SC
V35, Valve, Speed Control/Muffler	1	Arrow Pneumatics	1/4" Sintered Bronze Model ASP-2SC
V36, Valve, Steam Reducer	1	Keckley	1" Model S8
V37, Valve, Steam Shutoff	1	Lunkenheimer	1" Model 2140
V38, Valve, Water Shutoff	1	Asco	3/4" normally closed Model 821195
V39, Valve, Oil Recirc.	1	Ladish Tri-Clover	1-1/2" Model 821195
V40, Valve, Air Control	1	Numatics	1/4" Tapped Model 1JLSA3, 120/60
V41, Valve, Cold Trap Freon Control	1	Nupro	Metering Valve Series "M" Cat. No. B-4MG
V42, Valve Vacuum Breaker	1	Asco	1/4" NPT Tapped Medium vacuum range Model #8262C90VM

Electrical Systems

Equipment Item	Quantity	Suggested Manufacturer	Description
Programmable Controller	1	Furnas	Processor, Power Supply with Expansion Panel, I/O capability up to 256, Analog I/O, Programming Terminal.
Cabinet	1	Hoffman	Oil tight console with writing desk, full and half subpanels.
Temp. Controllers	2	Omega	Single Loop, Process Controller, Type T thermocouple input, 4-20 ma output, P.I.D. control, process and setpoint digital display and 2 alarm outputs.
Power Supply	1	Condor	24 VDC @ 7.2
Alarm	1	Floyd Bell Assoc.	Piezoelectric, waterproof, 6-30 V DC, panel mount.
Bargraph Display	1	Bowmar	100 segment display, LED, Input 4-20 mA.
Thermocouple Selector Switch	1	NANMAC	12 position, Type T
Thermocouple Selector Switch	1	NANMAC	2 position, Type T
Vacuum Process Controller	1	Newport	Proportional Controller adjustable setpoint over + 1999 range, 3-1/2 digit display, 4 - 20 mA Output, 0-10V DC Input
Pressure Transmitter/Transducer	1	MKS	Absolute type, range 0.03 - 1000 mm Hg, Accuracy 0.3% of reading, output signal 0 - 10V DC.
Liquid Level Transmitter/Transducer	1	Delta Controls	Ultrasonic type, output signal 4 - 20 MA 316 SS, Nema 4 enclosure

Equipment	Quantity	Suggested Manufacturer	Description
Flow Switch	2	Delta Controls	Direct inserted, 1-1/2 NPT, hermetically sealed switch, wetted materials 316 SS.
Limit Switches	15	Square D	Oiltight, Lever arm type
Display	2	Newport	3-1/2 digit display Type T thermocouple input, panel mount version
Pushbutton Illuminated	24	Micro-Switch	1 - Lamp, single section momentary action
Pushbutton Illuminated	1	Micro-Switch	1 - Lamp, single section alternate action
Indicator Illuminated	1	Micro-Switch	1 - Lamp, single section
Selector Switch	1	Square D	2 - position, spring return to center (off)
Potentiometer	1	Bourns	5K-OHM, 2 Watt, 10-Turn
Motor Controller	2	Woods	DC Variable Speed SCR Type
Terminal Lugs	6	Omega	Copper Alloy
Terminal Lugs	6	Omega	Constantan Alloy
Terminal Block	6	Cinch-Jones	20 Point
Terminal Block Box Lug	1	Square D	18 ea. GK-6 Section 2 ea GH-10 Clamp 18" Standard Channel
Disconnect Switch	1	Square D	100A Fusible, 240 V AC, 4 wire NEMA 12
Power Relay	1	Potter-Brumfield	120V AC Coil, 3 PST
Motor Starter	1	Square D	208V - 60 Hz - 3ϕ Control Voltage 120V - 60 Hz, Size 0
Motor Starter	1	Square D	208V - 60 Hz - 3ϕ Control Voltage 120V - 60 Hz, Size 0, Reversing
Motor Starter	1	Square D	208V - 60 Hz - 3ϕ Control Voltage 120V - 60 Hz, Size 1

Equipment	Quantity	Suggested Manufacturer	Description
Motor Starter	2	Square D	208V - 60 Hz - 3Ø Control Voltage 120V - 60 Hz, Size 00
Motor Starter	2	Square D	208V - 60 Hz - 1Ø Control Voltage 120V - 60 Hz
Circuit Breaker	1	Square D	100A Frame Thermal - mag, 3 Pole, 35 Amp
Circuit Breaker	1	Square D	100A Frame Thermal - mag, 3 Pole, 25 Amp
Circuit Breaker	1	Square D	100A Frame Thermal - mag, 3 Pole, 15 Amp
Circuit Breaker	2	Square D	100A Frame Thermal - mag, 2 Pole, 15 Amp
Control Relays	10	Potter-Brumfield	24V DC Coil with Socket
Fuse Block	6	Square D	Single Circuit

APPENDIX C

CONSTRUCTION STRATEGY

Construction Strategy

All materials and equipment shall be installed in accordance with the approved recommendations of the manufacturer to conform with the contract documents. The installation shall be accomplished by workmen skilled in this type of work.

Method of Construction

As much as practical, equipment shall be mounted on a minimum number of bases to facilitate site installation and relocation at a later date. All utilities and service lines shall terminate at one general location of the completed unit to facilitate hook up after installation.

Wiring and Conduit shall be installed as follows:

All fabrication and wiring of components internal to the control console (Figure 10) shall be accomplished and checked before delivery to the site. All component wiring external to the control console shall be performed at the site.

- Conduit shall be routed to avoid any interface with mechanical equipment, and piping.
- Conduit shall be rigid aluminum unless otherwise noted.
- All wiring shall be single conductor stranded copper, NEC type THWN size as noted.

Pipe shall be installed as follows:

- Unless otherwise specified herein, pipe and fitting shall conform to the requirements of ANSI B31.1.
- Pipe shall be cut accurately to measurements established at the job site, worked into place without springing or forcing, and properly clear windows, doors, and other openings. Cutting or other weakening of the building structure to facilitate piping installation will not be permitted.
- Pipes shall have burrs removed by reaming, and shall be so installed as to permit free expansion and contraction without causing damage to building structure, pipe, joints, or hangers.
- Changes in direction shall be made with fittings, except that bending of pipe up to four inches will be permitted, provided a pipe bender is used and wide sweep bends are formed. The center line radius of bend shall be not less than six diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening or other malformations will not be accepted.

- Horizontal mains shall pitch up or down in the direction of flow. The grade shall be not less than 1 inch in 40 feet.

- Reduced fittings shall be used for changes in pipe sizes.

- Open ends of pipelines and equipment shall be properly capped or plugged during installation to keep dirt or other foreign materials out of the systems.

- Pipe not otherwise specified shall be uncoated.

- Connections between ferrous and copper piping shall be electrically isolated from each other with dielectric unions and meet the joint requirements.

Joints shall be made up as follows:

- Ream all pipe ends before joint connections are made.

- Screwed joints shall be made up with a teflon filled compound and not more than three threads shall show after joint is made-up.

- Joint compounds shall be applied to the male thread only, and care shall be exercised to prevent compound from reaching the interior of the pipe.

- Screwed unions, welded unions or bolted flanges shall be provided wherever required to permit convenient, maintenance-wise removal of equipment, valves, and piping accessories from the piping system.

- Field welded joints shall conform to the requirements of the AWS, ANSI B31.1-1973, and the requirements of Division 17 - "Welding, Brazing and Soldering".

- Flanged joints shall be assembled with appropriate flanges, gaskets, and bolting. the clearance between flange faces shall be such that the connections can be gasketed and bolted tight without imposing undue strain on the piping system.

- Copper tubing for solder joints shall be cut square and burrs shall be removed with approved cutting and reaming tools. Inside surfaces of fittings and outside surfaces of tubes in joint area shall be cleaned with steel wool before assembly of joint. Joint flux, filler material and heat source shall be applied in accordance with the manufacturer's instructions to provide proper capillary action to fill the socket space and to achieve 100 percent of shear-line strength capability. Valves in copper piping shall have screwed ends with end adapters to suit mechanical connections, unless solder jointing is specified or indicated for a given application. Copper joints which fail pressure tests shall be remade with new materials including pipe or tubing fitting, and filler metal.

  Copper tubing with mechanical joints shall be cut square and burrs shall be removed with approved cutting and reaming tools. Care shall be exercised to not work hardened copper surfaces and in case of doubt, tube ends shall be cut off or annealed by heating to a temperature and air cooling in accordance with the manufacturer's instructions.

Supports shall be installed as follows:

- Supporting elements shall be provided in accordance with the referenced codes, standards and requirements specified herein.

- Piping shall be supported from building structure. No piping shall be supported from roof deck, or from other pipe.

- If flange loads on connected equipment are allowed, these shall not exceed 75 percent of maximum allowed by equipment manufacturer.

- All piping shall run parallel with the lines of the building unless otherwise indicated. Piping and components shall be spaced and installed so that a threaded pipe fitting may be removed between adjacent pipes and so that there will be not less than 1/2 inch of clear space between the finished surface and other work and between the finished surface of parallel adjacent piping. Hangers on different adjacent service lines running parallel with each other shall be arranged to be in line with each other and parallel to the lines of the building.

- Piping support elements shall be installed at intervals specified hereinafter, at locations not more than 3 feet from the ends of each runout and not over 1 foot from each change in direction of piping. The load rating for all pipe hanger supports shall be based on insulated weight of lines filled with water and forces imposed. The deflection per span shall not exceed slope gradient of pipe. Supports shall be in accordance with the following minimum rod size and maximum allowable hanger spacing for specified pipe. For concentrated loads, such as valves, reduce allowable span proportionately:

Pipe Size Inches	Rod Size Inches	Ferrous Pipe Feet	Copper Tube Feet
1/2 and Smaller	3/8	8	3
3/4 - 1	3/8	8	5
1-1/4 1-1/2	3/8	10	7
2	3/8	12	7

Testing shall be performed as follows:

- General - Systems shall be tested for leaks per the following paragraphs. Unless otherwise noted, test medium shall be clean potable water. All flexible joints shall not be tested. After successful testing is complete, drain piping, if applicable, and apply insulation where required.

- A Test Procedure shall be prepared indicating all requirements and with provisions for data recording.

- Steam, hot water and water piping - Hydrostatically test to 1-1/2 times the working pressure and hold for 2 hours with no drop in pressure or leaks.

- Drain Piping - Hydrostatically test at 5 psig and hold for2 hours with no drop in pressure or leaks.

- Vacuum Piping - Pneumatic test at 5 psig and check with leak detector solution, no leakage will be acceptable.

- Lipoidal Liquid Piping - Hydrostatically test at 125 psig and hold for 2 hours with no drop in pressure or leaks.

- Control Air Tubing - Pneumatic test with oil free compressed air to system pressure in 25 psig increments at 1/2 hour per increment. Check with leak detector solution.

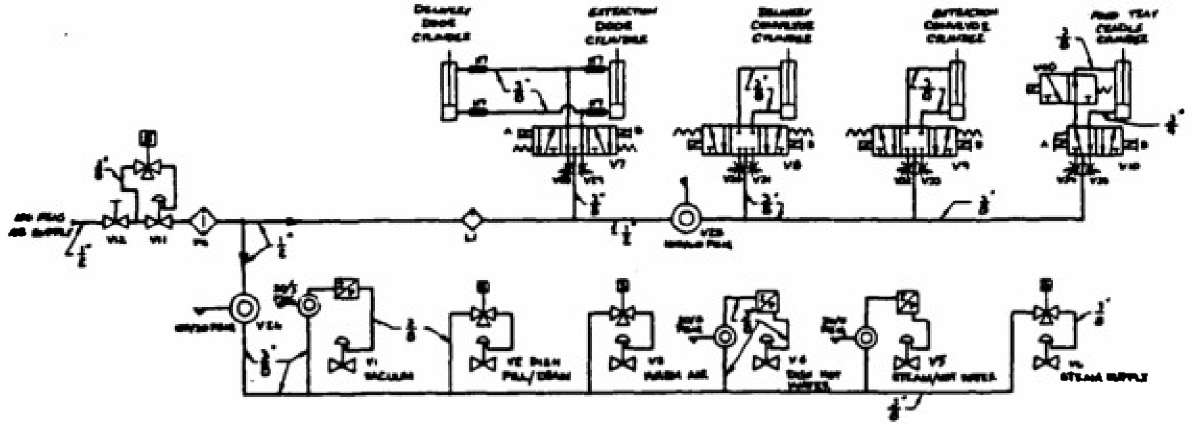
- Refrigerant Tubing - Pneumatic test with dry nitrogen to minimum pressures specified per ANSI B9.1 for refrigerant used. Check with leak detector solution.

- Warm and Chilled Air System - Ducts, plenums, and casings shall be tested and made substantially airtight at static pressure indicated for the system before covering with insulation. The term, substantially airtight, shall be construed to mean that no air leakage is noticeable through the senses of feeling or hearing.

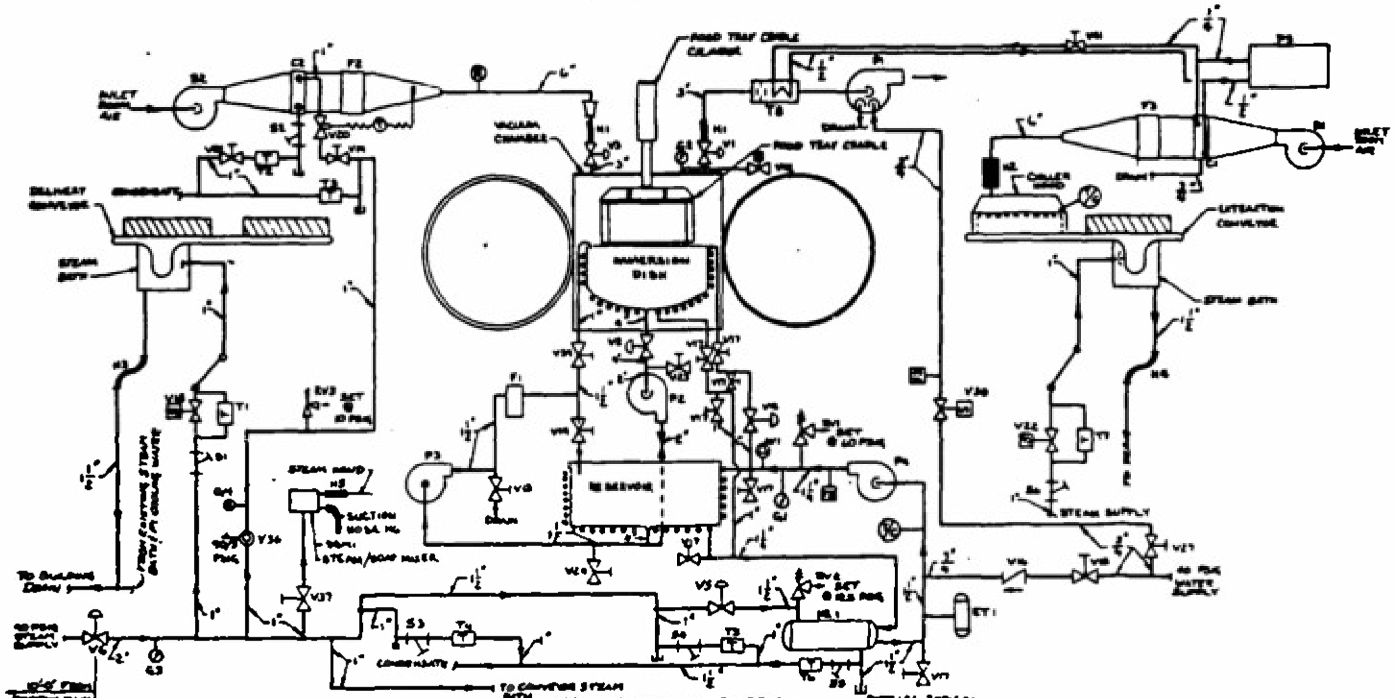
APPENDIX D

LIST OF DRAWINGS *	
BI DWG. NO.	DRAWING TITLE
B12553	COVER SHEET & LIST OF DRAWINGS
B12554	SYSTEM DIAGRAM
B12555	SYSTEM INSTALLATION PLAN VIEW
B12556	SYSTEM INSTALLATION ELEVATION
D12557	VACUUM CHAMBER ARRANGEMENT
D12558	VACUUM CHAMBER - TYPICAL DETAILS
B12559	CONVEYOR ARRANGEMENT - DELIVERY
C12560	CONVEYOR ARRANGEMENT - EXTRACTION & CONVEYOR TRACK
B12561	CHILLER HOOD & AIR BOX
B12562	OIL RESERVOIR, IMMERSION DISH & FOOD TRAY
B12564	POWER BLOCK DIAGRAM
D12565	PROCESS BLOCK DIAGRAM
D12566	ELECTRICAL SCHEMAYIC-SHEET 1 OF 4
B12567	ELECTRICAL SCHEMAYIC-SHEET 4 OF 4
B12568	ELECTRICAL SCHEMAYIC-SHEET 2 OF 4
B12569	ELECTRICAL SCHEMATIC-SHEET 3 OF 4
B12570	CONTROL CONSOLE ASSEMBLY
B12571	OPERATOR'S CONTROL PANEL ASSEMBLY
B12572	TEMPERATURE CONTROL PANEL ASSEMBLY
B12573	CONDUIT ARRANGEMENT-POWER & INSTRUMENT
B12574	CONDUIT ARRANGEMENT-CONTROL
B12575	INTERCONNECTION DIAGRAM-SHEET 1 OF 2
B12576	INTERCONNECTION DIAGRAM-SHEET 2 OF 2

* NOTE: Original Copies of These Drawings are Available through the Project Officer at Natick.



PNEUMATIC DIAGRAM

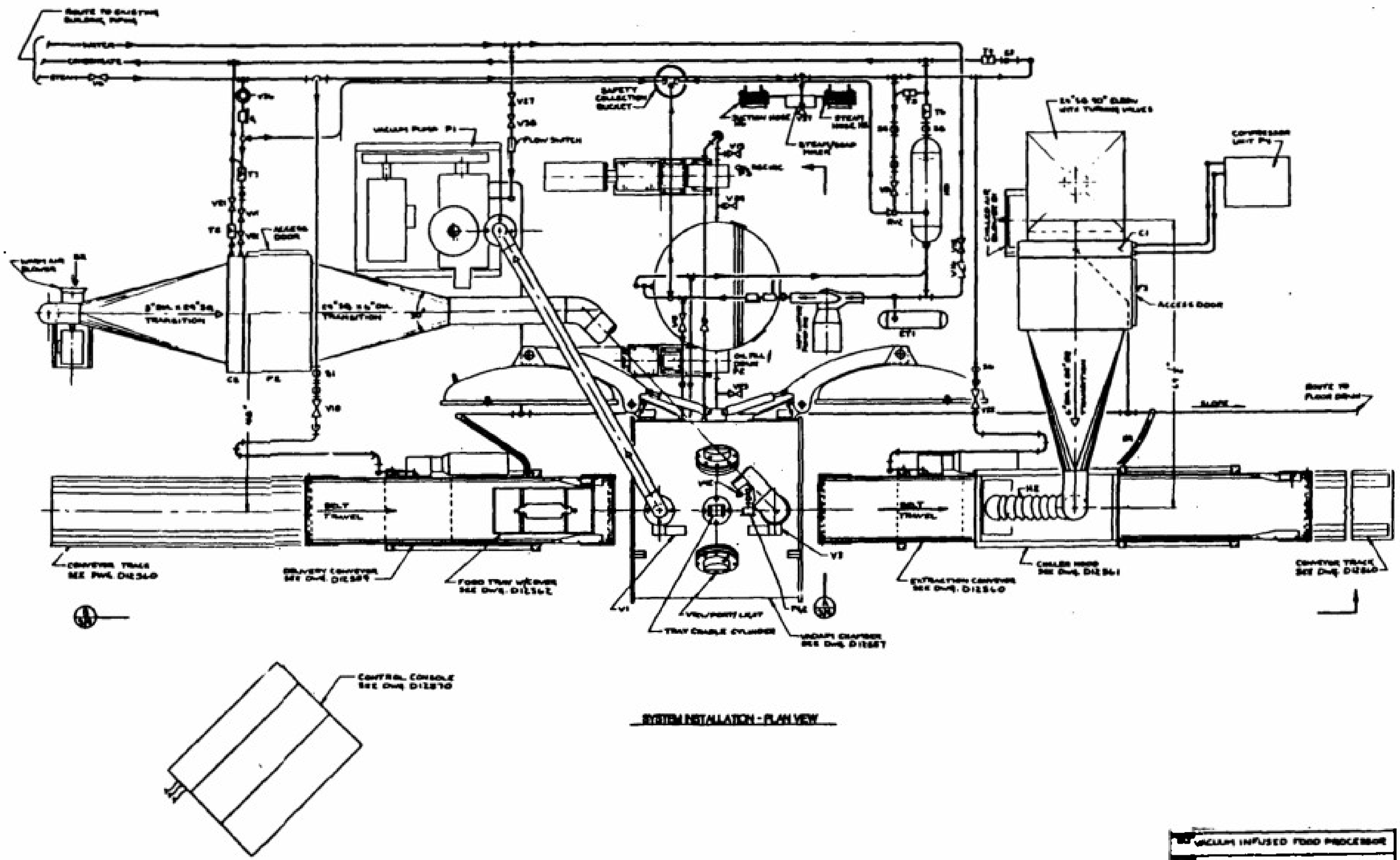


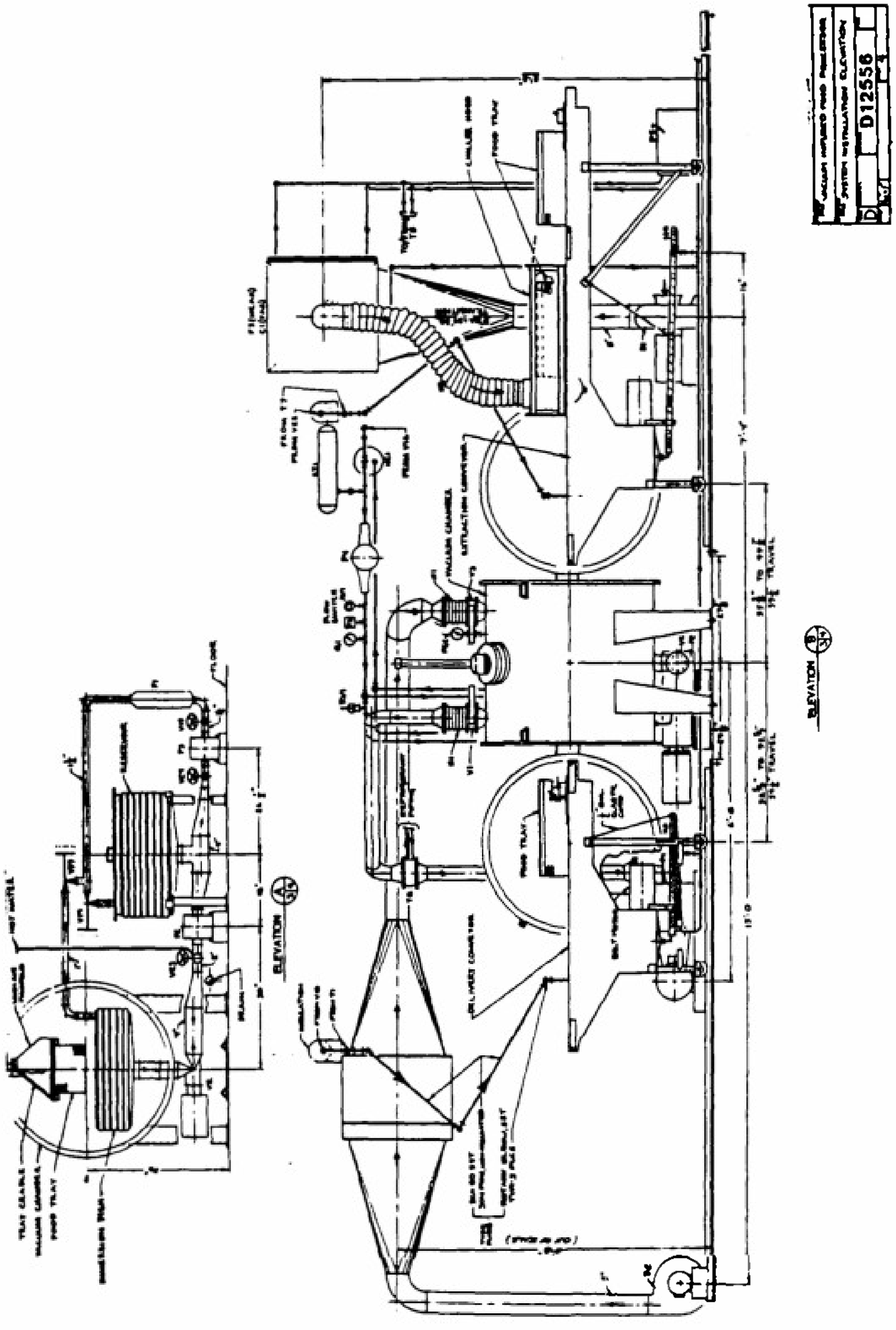
MECHANICAL SYSTEM DIAGRAM

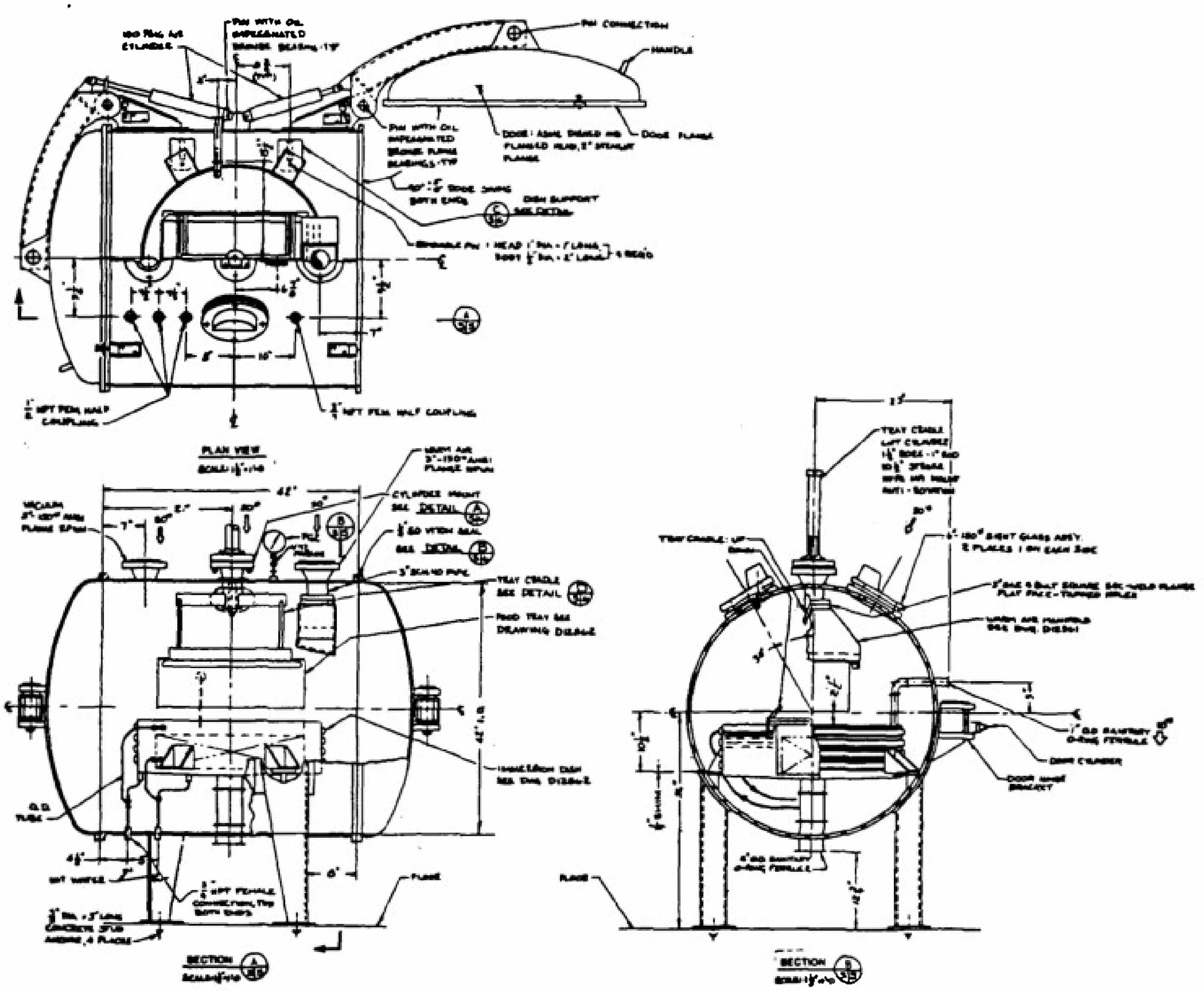
LEGEND

- FLEXIBLE CONNECTION
- VALVE - MANUAL
- VALVE - PNEUMATIC
- VALVE - SOLENOID
- VALVE - SAFETY RELIEF
- STRAINER - STEAM
- VALVE - CHECK
- TRAP - STEAM
- TRAP - VACUUM
- GAUGE
- FLOW SWITCH
- AIR ELIMINATOR
- VALVE - PRESSURE REDUCING

VACUUM INFUSED FOOD PROCESSOR	
SYSTEM DIAGRAM	
D	D12554
NTS	2


SYSTEM INSTALLATION - PLAN VIEW
ACCESS DOOR
VACUUM INFUSED FOOD PROCESSOR
SYSTEM INSTALLATION PLAN VIEW
D
D12555


ELEVATION
ELEVATION
D12556

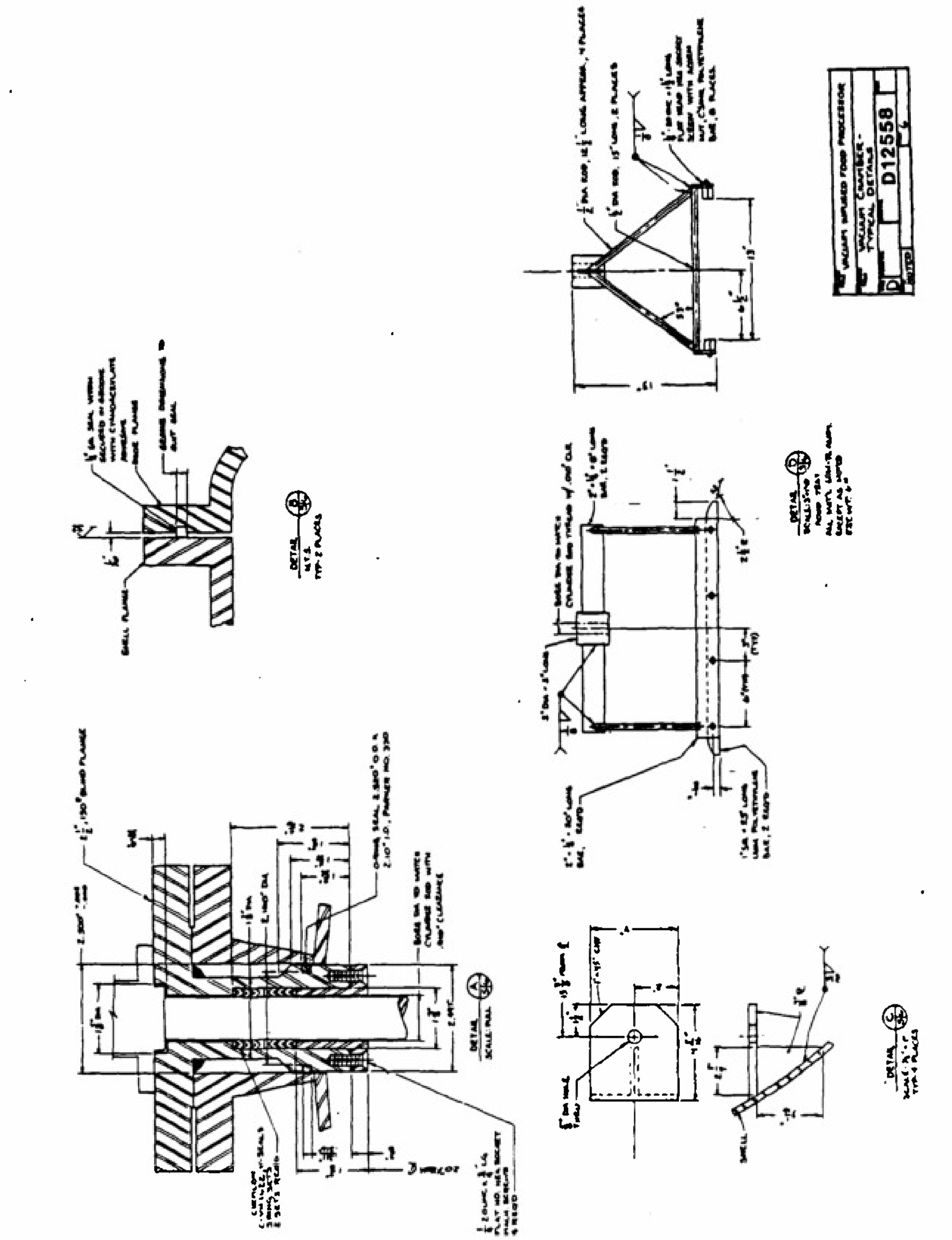


VACUUM INFUSED FOOD PROCESSOR

VACUUM CHAMBER ARRANGEMENT

D | D12557

NOTED | 5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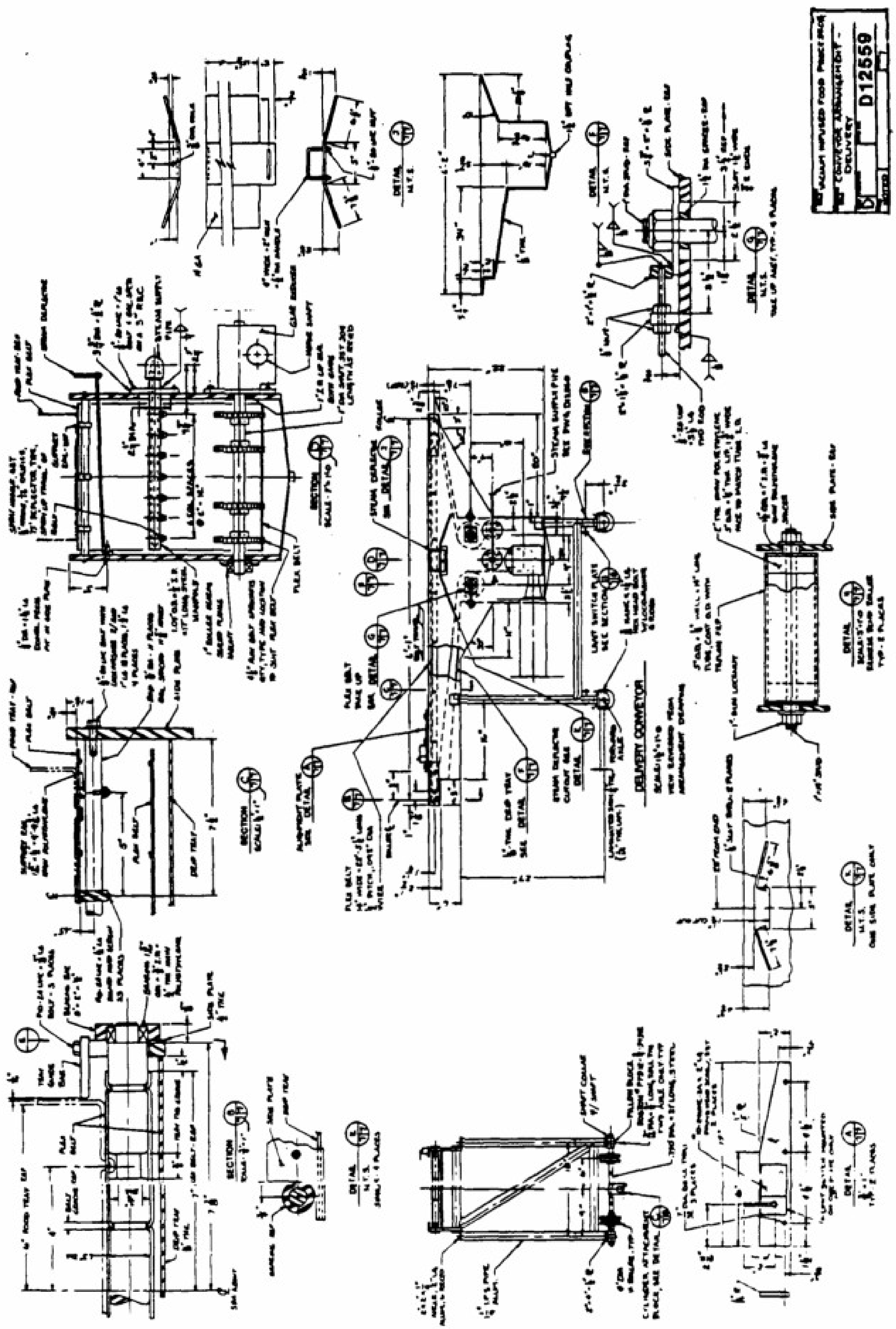
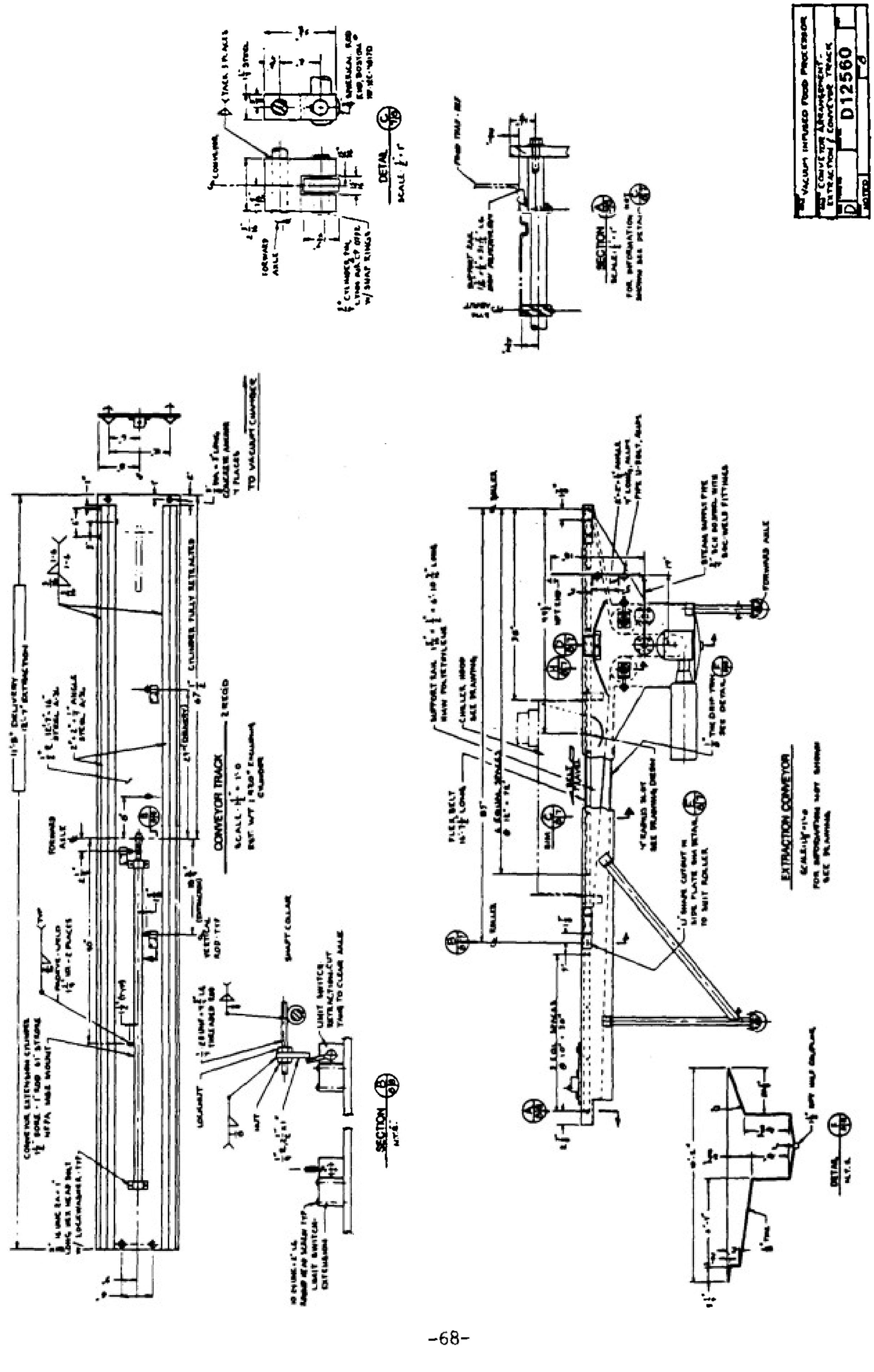
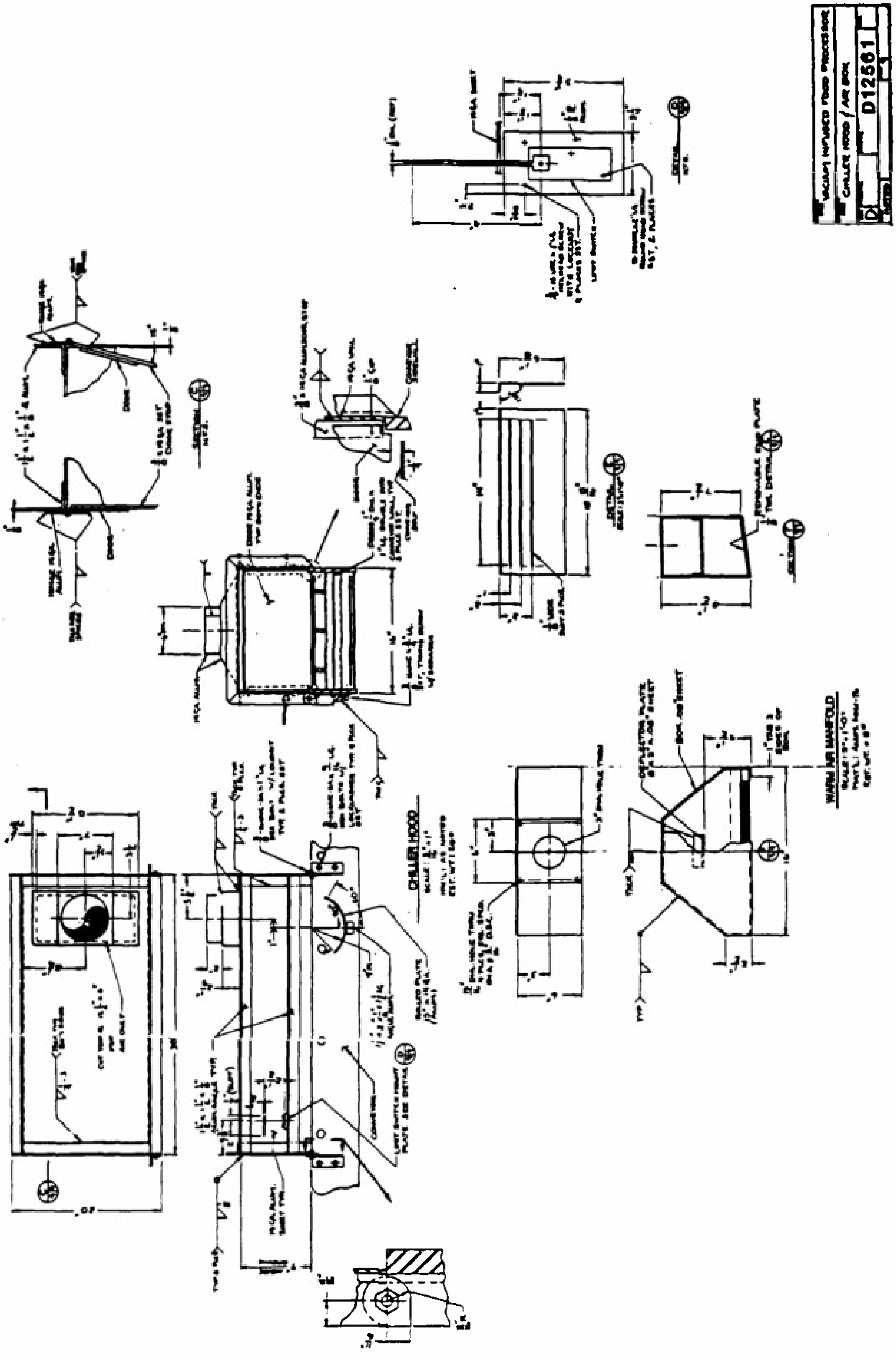
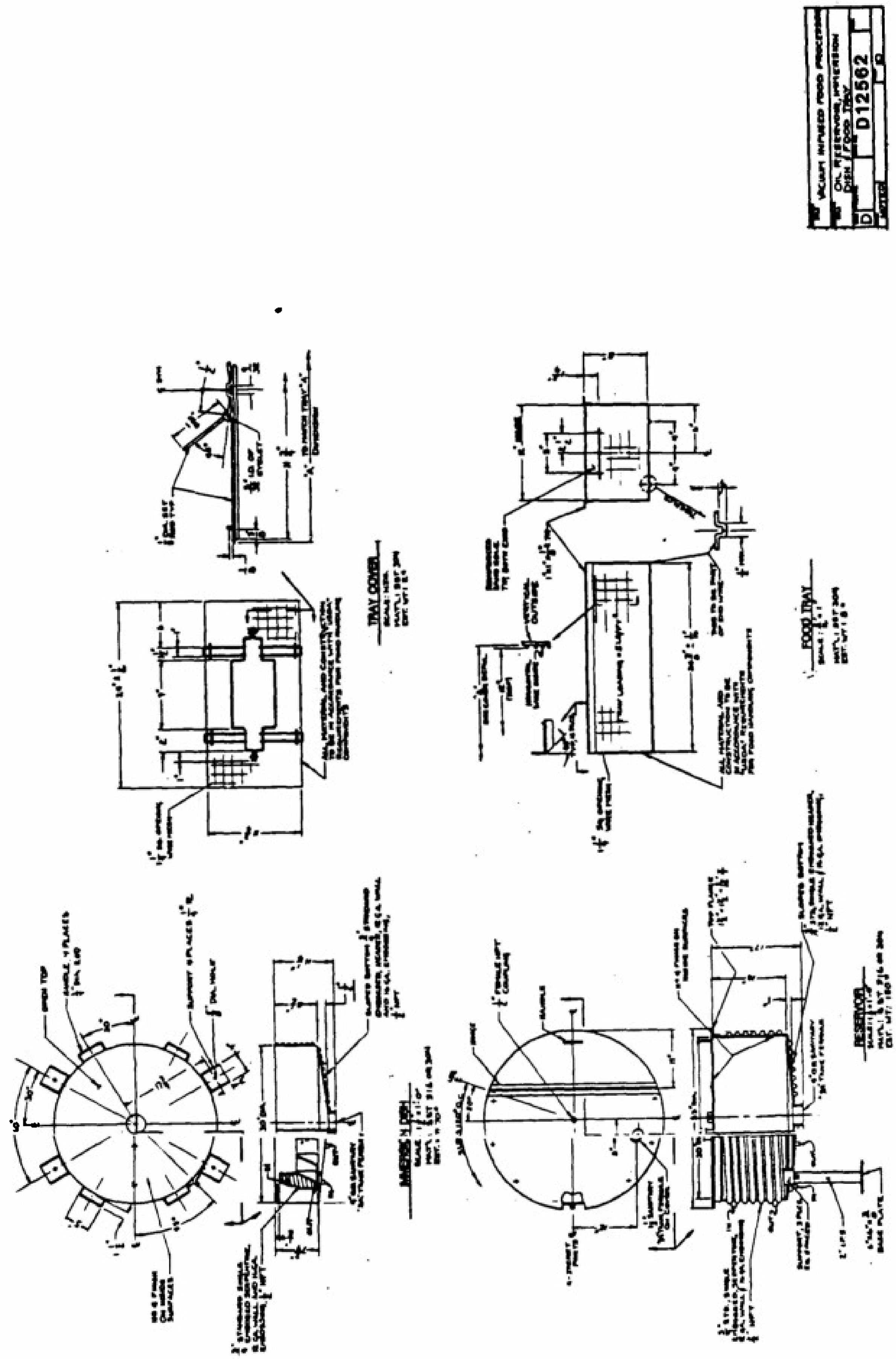
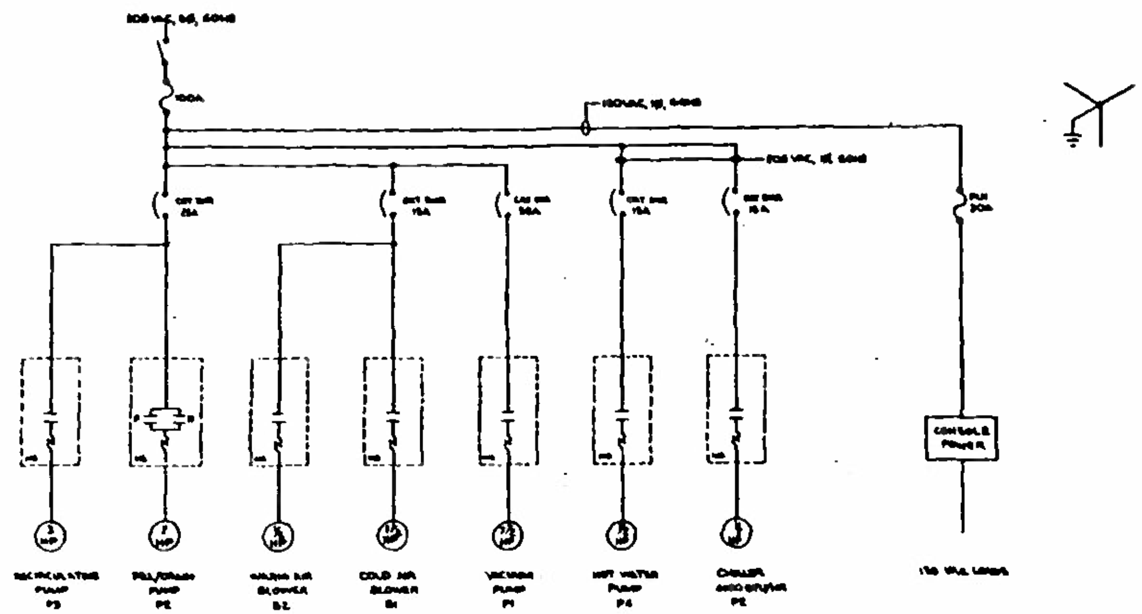
VACUUM CHAMBER - TYPICAL DETAILS
D12558


DELIVERY CONVEYOR
VACUUM INFUSED FOOD PROCESSOR
CONVEYOR ARRANGEMENT - DELIVERY
D12559


VACUUM INFUSED FOOD PROCESSOR
CONVEYOR ARRANGEMENT - EXTRACTION / CONVEYOR TRACK
D12560
CONVEYOR TRACK
EXTRACTION CONVEYOR
TO VACUUM CHAMBER
FORWARD AXLE
SECTION
DETAIL

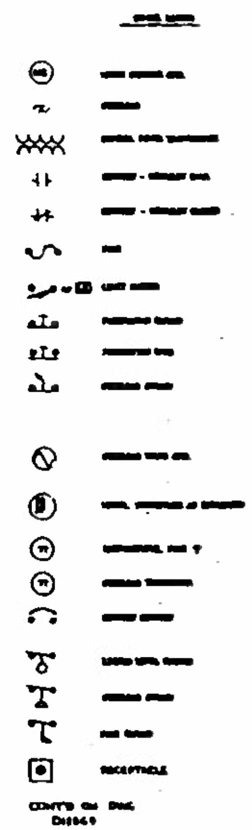

D12561
CHILLER HOOD
WARM AIR MANIFOLD


VACUUM INFUSED FOOD PROCESSOR
OIL RESERVOIR, IMMERSION DISH / FOOD TRAY
D12562
TRAY COVER
FOOD TRAY
IMMERSION DISH
RESERVOIR



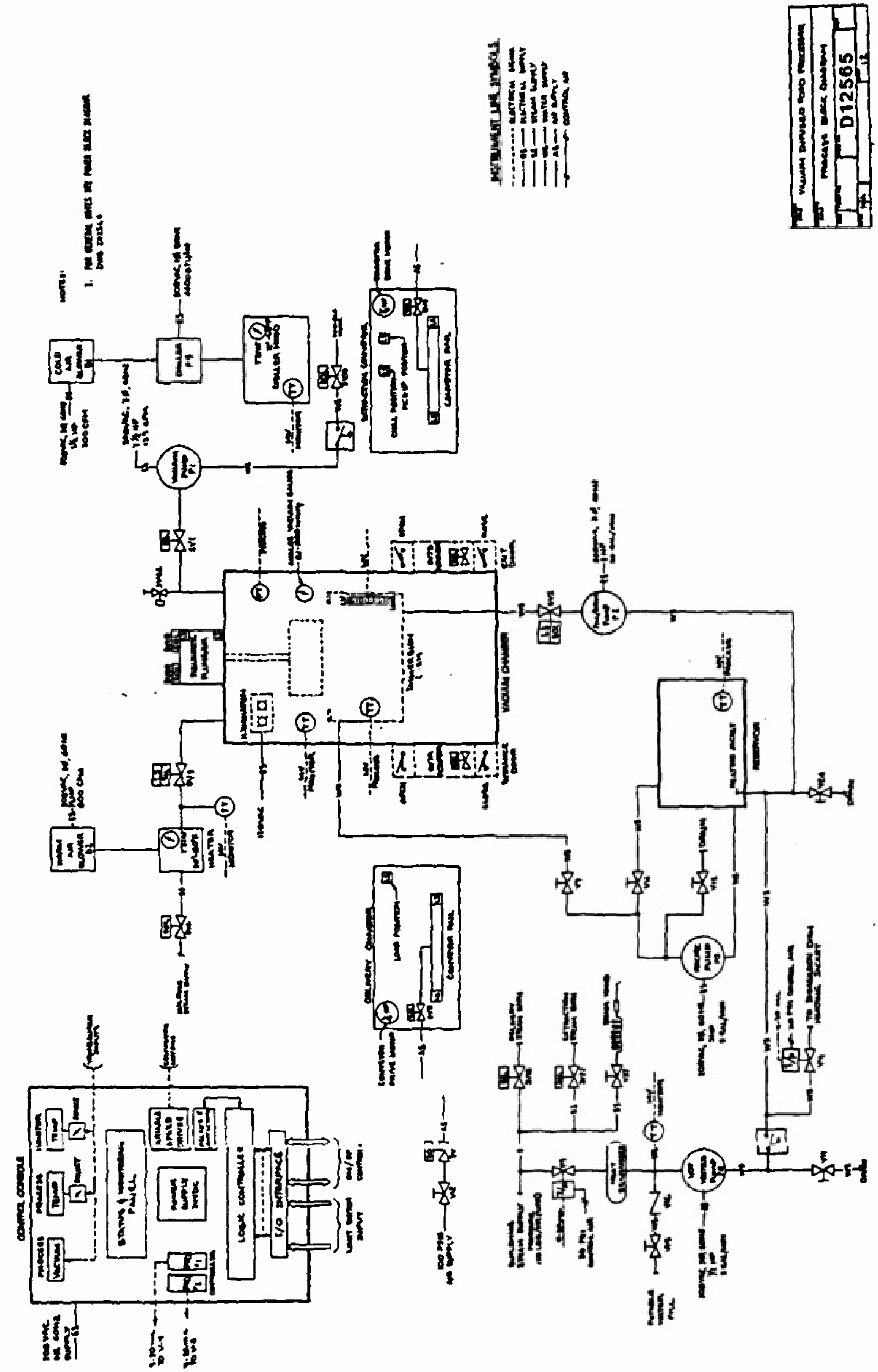
NOTES

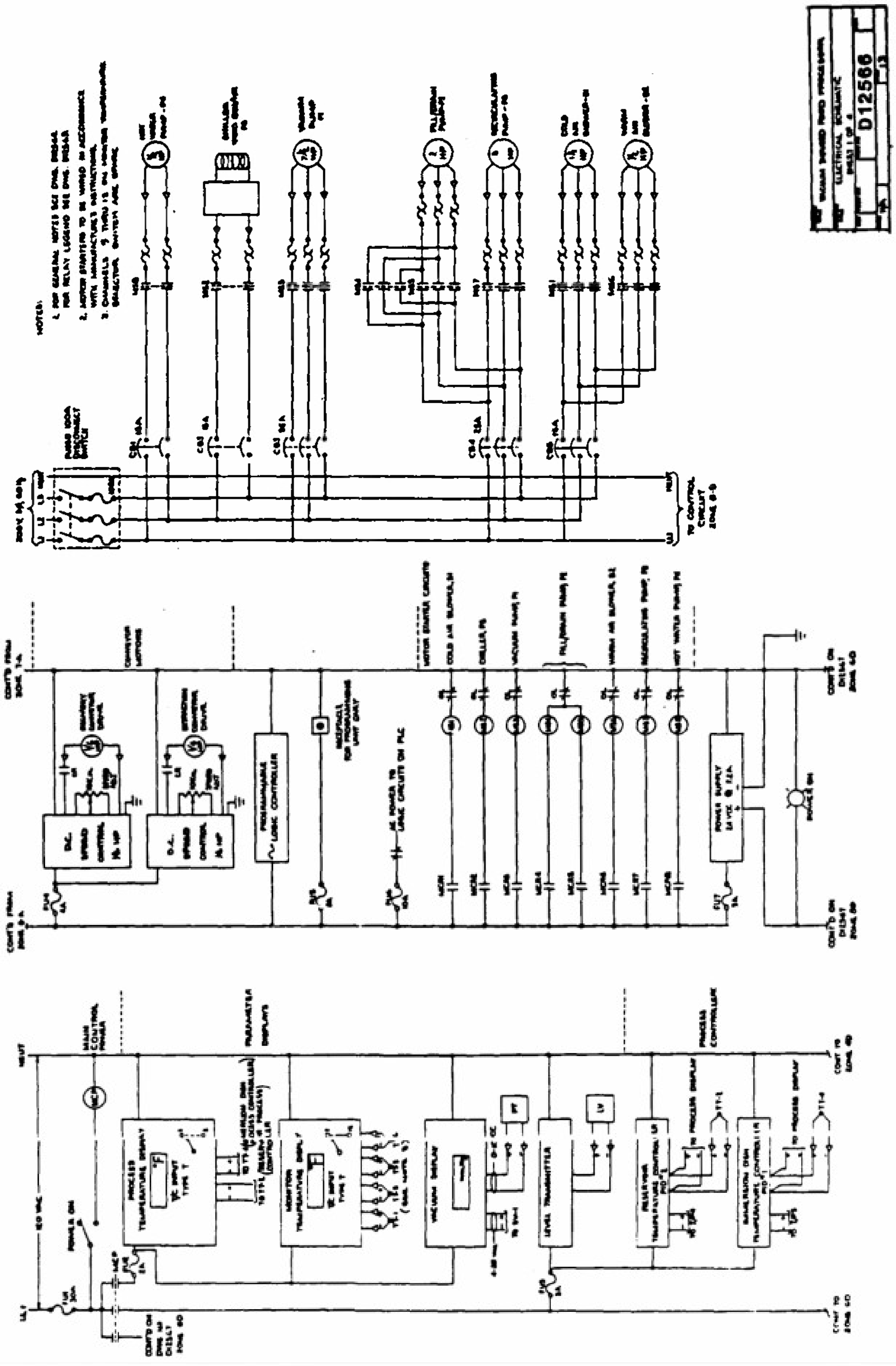
1. CONDUIT SHALL BE ROUTED TO AVOID ANY INTERFERENCE WITH EXISTING MECHANICAL EQUIPMENT, PIPING, ETC.
2. THE CONTRACTOR SHALL FURNISH THE NECESSARY MATERIALS SUCH AS CONDUIT, CONDUIT FITTINGS AND WIRING SUPPLIES AS REQUIRED TO COMPLETE THE ELECTRICAL INSTALLATION IN ACCORDANCE WITH THE NATIONAL ELECTRICAL CODE.
3. DENOTES EQUIPMENT OR COMPONENTS WHERE OPERATIONAL AND INTERFACE CHARACTERISTICS SHALL BE DETERMINED BY THE GOVERNMENT.
4. NEW CONDUIT TO FOLLOW EXISTING CONDUIT RUN, WHERE APPLICABLE.
5. CONTRACTOR SHALL VERIFY EXACT LOCATION OF ALL EXISTING EQUIPMENT.
6. ALL RACEWAYS, CONDUCTORS AND EQUIPMENT SHALL BE INSTALLED AND GROUNDED IN ACCORDANCE WITH THE NATIONAL ELECTRIC CODE.
7. ALL WIRING SHALL BE SINGLE CONDUCTOR STRANDED COPPER. NEC TYPE THW SIZE AS NOTED.
8. ALL DIMENSIONS ARE APPROXIMATE AND FOR GUIDANCE ONLY.
9. FOR CONTROL CONSOLE ASSY SEE DWG D12570.
10. FOR ELECTRICAL SCHEMATICS SEE DWG D12566 THRU D12569.
11. FOR CONDUIT ARRANGEMENT SEE DWGS D12573 & D12574.
12. FOR INTERCONNECTION DIAGRAMS SEE DWGS D12575 & D12576.

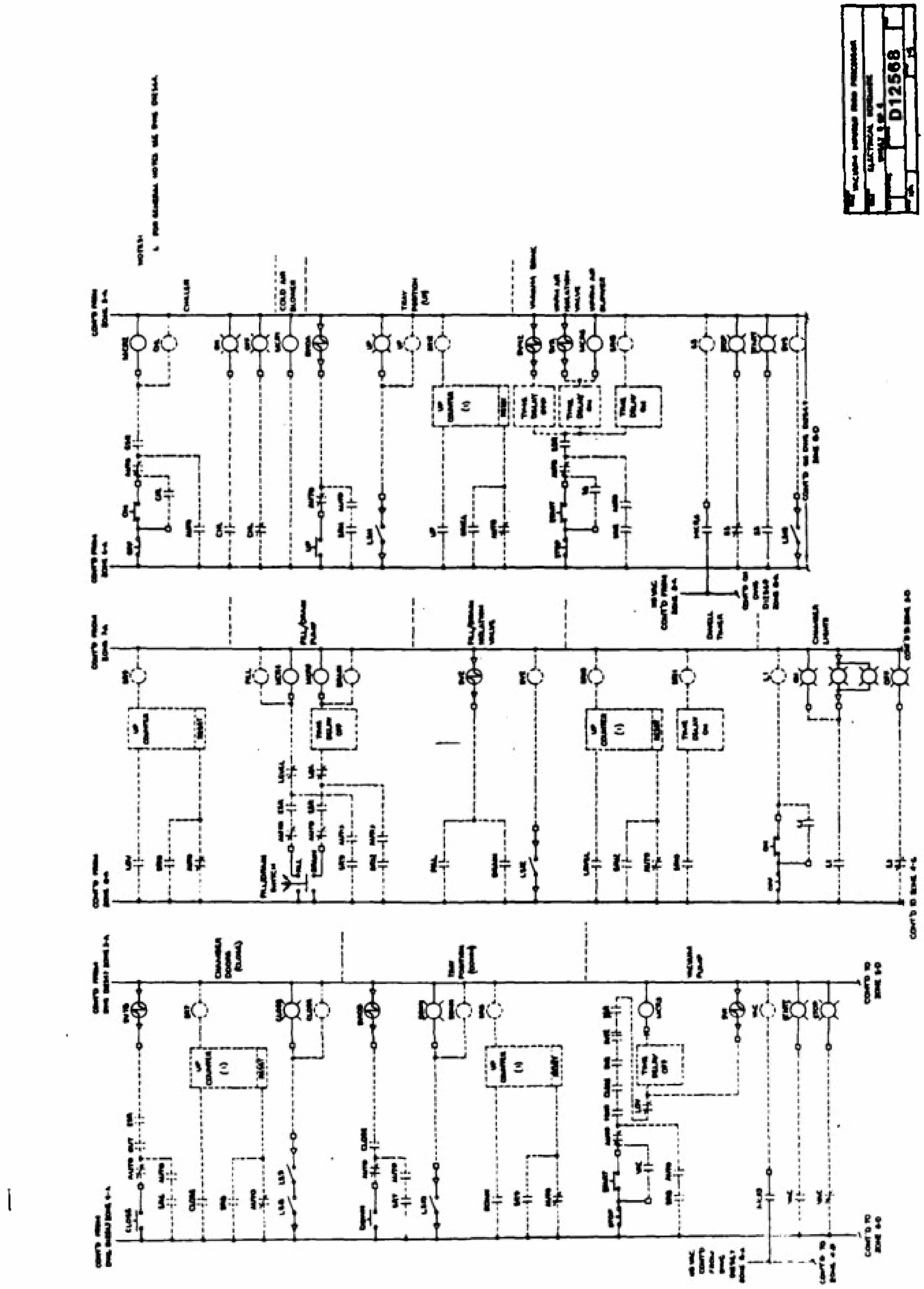


POWER BLOCK DIAGRAM

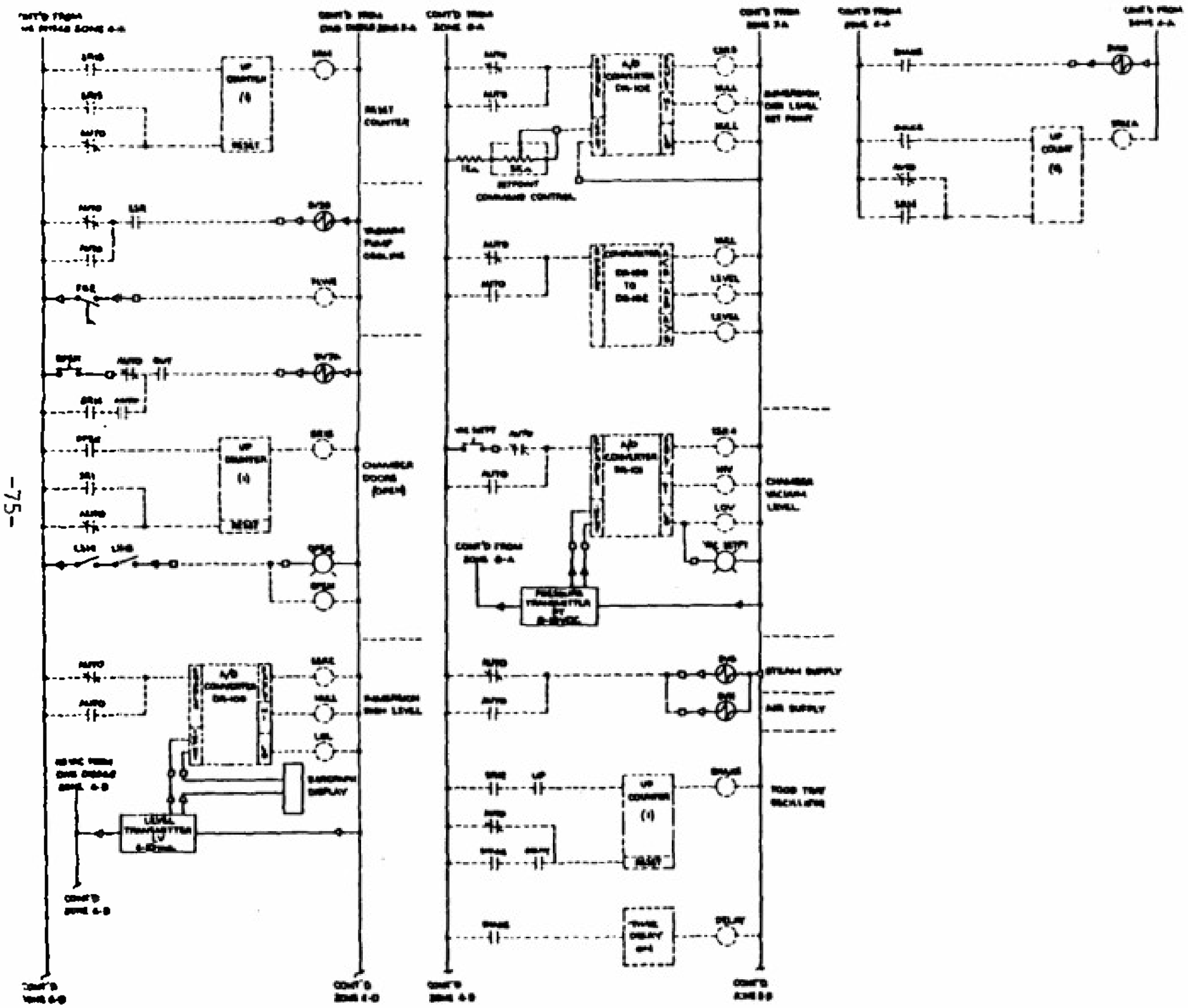
D12564


D12565

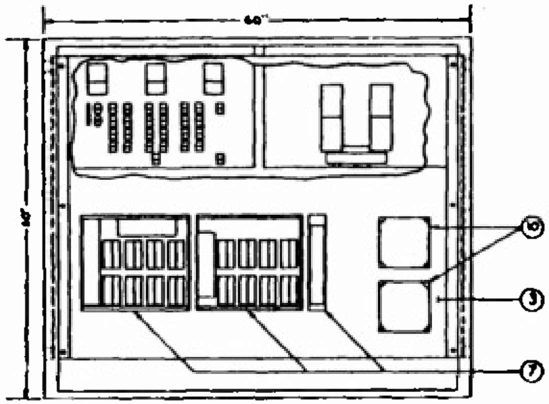

D12566


D12568

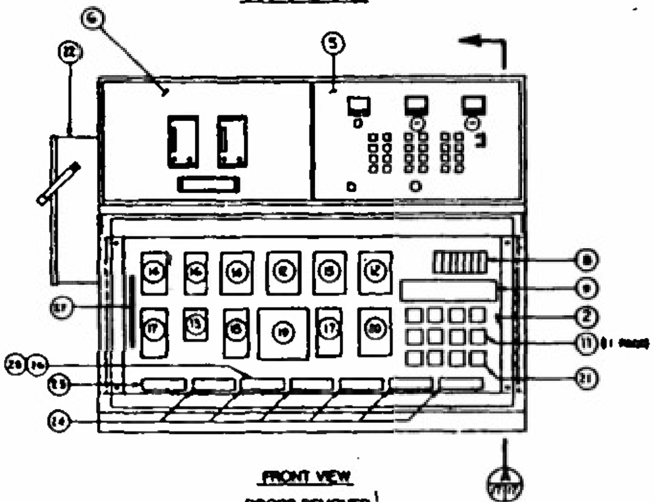
NOTES:
1. FOR GENERAL NOTES SEE DWG D12364.



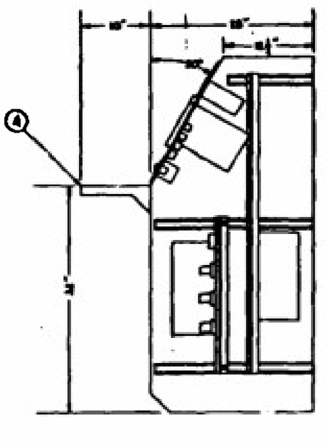
VACUUM INFUSED FOOD PROCESSOR
ELECTRICAL SCHEMATIC
SHEET 4 OF 4
D12569



REAR VIEW
DOORS REMOVED



FRONT VIEW
DOORS REMOVED



ELEVATION A

CONTROL CONSOLE ASSEMBLY

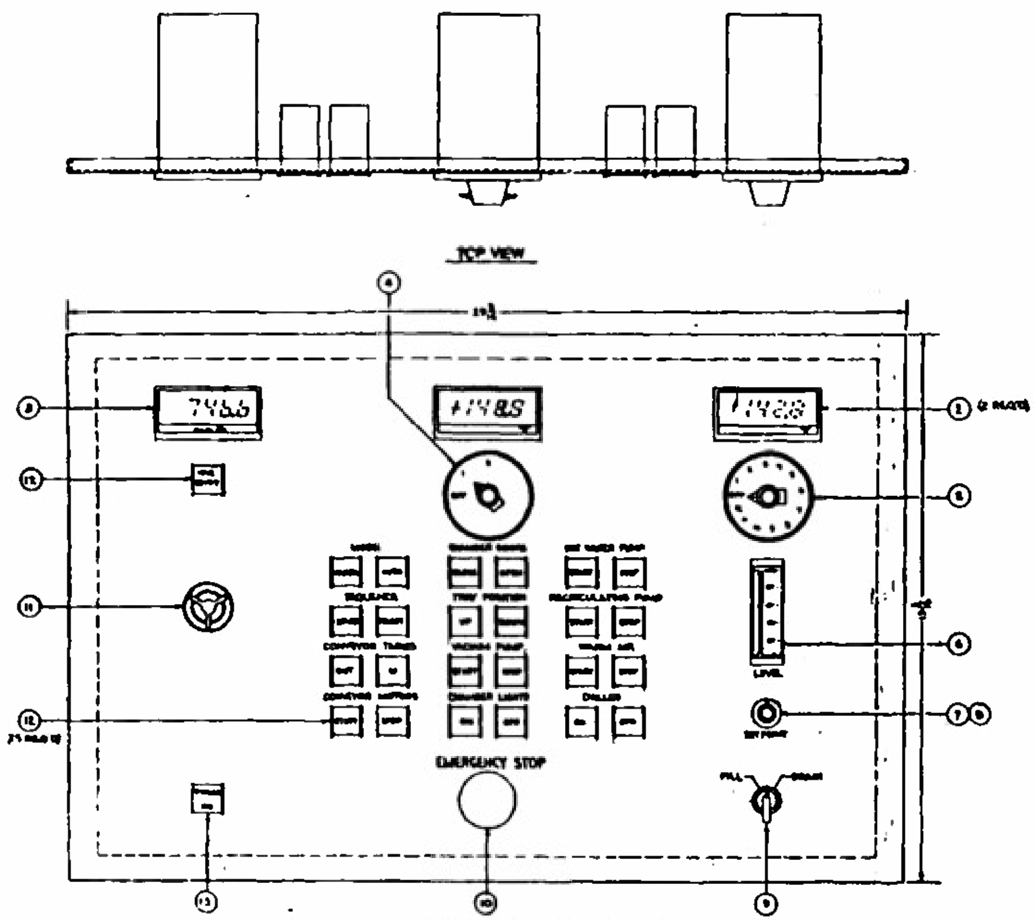
NOTES:
1. FOR GENERAL NOTES SEE DWG [illegible]

ITEM	QTY	DESCRIPTION	MFR	CAT. NO.	REMARKS
27	1	GROUND BAR	SQUARE D	[illegible]	
26	6	TERMINAL, LUGS, ALLOY	[illegible]	[illegible]	COPPER
25	6	TERMINAL, LUGS, ALLOY	[illegible]	[illegible]	[illegible]
24	6	TERMINAL BLOCK	CINCH-JONES	[illegible]	20 POINT
23	1	TERMINAL BLOCK, BOX LUG	SQUARE D	[illegible]	[illegible]
22	1	DISCONNECT SWITCH, 100A, FUSIBLE	SQUARE D	[illegible]	[illegible]
21	1	POWER RELAY, 3PST 7 AMP CONTACTS	POTTER-BRUMFIELD	[illegible]	[illegible] COIL
20	1	MOTOR STARTER, SIZE 0	SQUARE D	[illegible]	[illegible]
19	1	MOTOR STARTER, SIZE 0 REVERSING	SQUARE D	[illegible]	[illegible]
18	1	MOTOR STARTER, SIZE 1	SQUARE D	[illegible]	[illegible]
17	2	MOTOR STARTER, SIZE 00	SQUARE D	[illegible]	[illegible]
16	2	MOTOR STARTER, SIZE 00	SQUARE D	[illegible]	[illegible]
15	1	CIRCUIT BREAKER, 3-POLE, [illegible] AMP	SQUARE D	[illegible]	[illegible] FRAME THERMAL MAGNETIC
14	1	CIRCUIT BREAKER, 3-POLE, [illegible] AMP	SQUARE D	[illegible]	[illegible] FRAME THERMAL MAGNETIC
13	1	CIRCUIT BREAKER, [illegible]	SQUARE D	[illegible]	[illegible] FRAME THERMAL MAGNETIC
12	2	CIRCUIT BREAKER, [illegible] 15 AMP	SQUARE D	[illegible]	[illegible] FRAME THERMAL MAGNETIC
11	11	CONTROL RELAYS, DPDT	POTTER-BRUMFIELD	[illegible]	[illegible] COIL
10	2	DC MOTOR CONTROLLER	WOODS	[illegible]	
9	1	POWER SUPPLY	CONDOR INC	[illegible]	[illegible]
8	7	FUSEBLOCK, SINGLE CIRCUIT	SQUARE D	[illegible]	FUSE SIZE AS REQUIRED
7	1	PROGRAMMABLE CONTROLLER	[illegible]	[illegible]	[illegible] MEMORY [illegible]
6	1	TEMPERATURE CONTROL PANEL	[illegible]	PART OF ITEM 1	[illegible]
5	1	OPERATOR'S CONTROL PANEL	[illegible]	PART OF ITEM 1	[illegible]
4	1	WRITING DESK	HOFFMAN ENGR CO	[illegible]	[illegible]
3	1	SUBPANEL, FULL	HOFFMAN ENGR CO	[illegible]	[illegible]
2	1	SUBPANEL, HALF	HOFFMAN ENGR CO	[illegible]	[illegible]
1	1	OIL TIGHT SLOPED-FRONT CONSOLE CABINET	HOFFMAN ENGR CO	[illegible]	[illegible]

LIST OF MATERIAL

CONTROL CONSOLE ASSEMBLY

D12570



TOP VIEW

OPERATOR'S CONTROL PANEL ASSEMBLY

FRONT VIEW

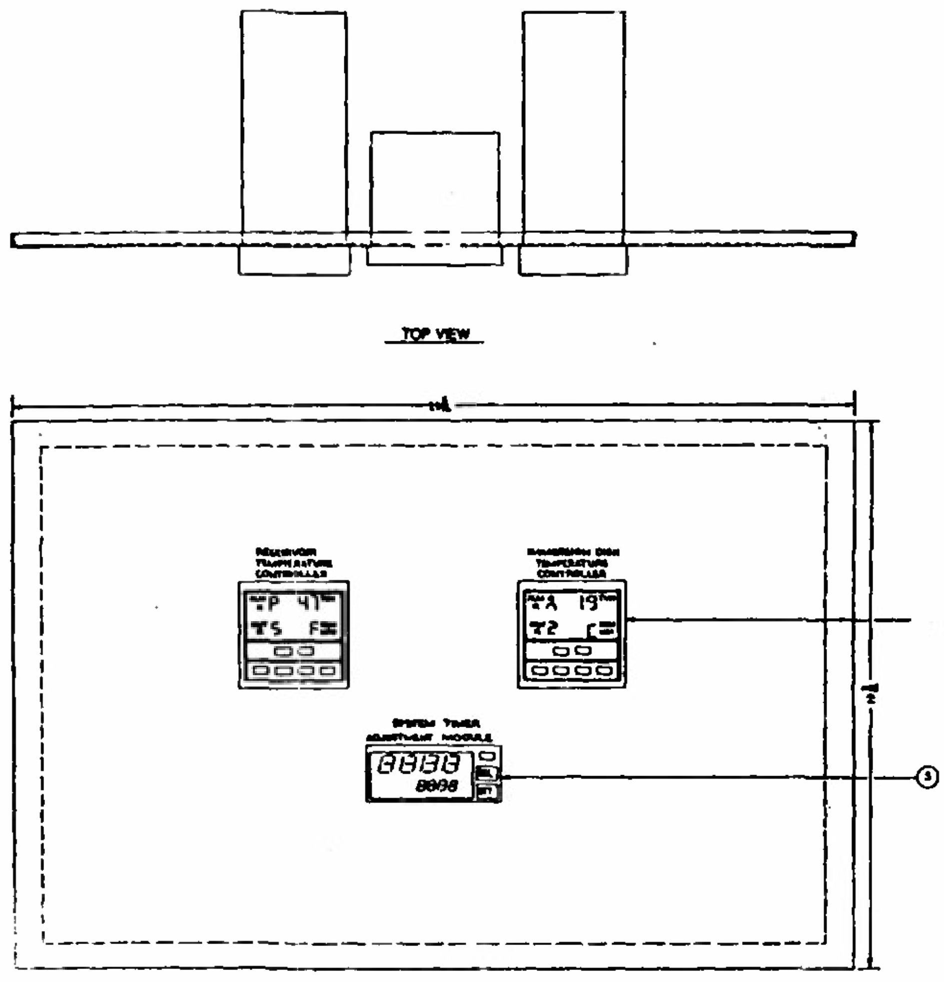
NOTES:

1. THE EQUIPMENT FOR THIS ASSEMBLY SHALL BE AS LISTED IN THE MATERIAL LIST OR OF EQUAL QUALITY AND PERFORMANCE.
2. ALL DIMENSIONS ARE APPROXIMATE AND FOR GUIDANCE ONLY.
3. ALL HOOKUP WIRE SHALL BE STRANDED COPPER, THERMOPLASTIC INSULATED (PVC) MLC TYPE MTW—600 VOLT NO SMALLER THAN AWG [illegible] EXCEPTION – THERMOCOUPLE WIRE.
4. THE CONTRACTOR SHALL FURNISH ALL MISCELLANEOUS HARDWARE ITEMS SUCH AS SCREWS, NUTS, BRACKETS, [illegible], CLAMPS, TERMINAL LUGS, WIRE AND OTHER SMALL PARTS REQUIRED FOR THE FABRICATION OF THIS ASSEMBLY.
5. FOR GENERAL NOTES SEE DWG [illegible].

ITEM	QTY	DESCRIPTION	MFR	MFR. NO.	REMARKS
13	1	PUSHBUTTON, ILLUMINATED	MICRO SWITCH	[illegible]	[illegible]
12	25	PUSHBUTTON, ILLUMINATED	MICRO SWITCH	[illegible]	[illegible]
11	1	ALARM, 24VDC	[illegible]	[illegible]	[illegible]
10	1	PUSHBUTTON, [illegible]	[illegible]	[illegible]	[illegible]
9	1	3-POSITION SELECTOR SWITCH	[illegible]	[illegible]	[illegible] RETURN TO CENTER (OFF)
8	1	POTENTIOMETER	[illegible]	[illegible]	[illegible] 10-TURN
7	1	TURNS COUNTING DIAL	SPECTROL	[illegible]	
6	1	BARGRAPH, [illegible] SEGMENT	[illegible]	[illegible]	[illegible]
5	1	THERMOCOUPLE SELECTOR SWITCH	[illegible]	[illegible]	[illegible]-POSITION & OFF
4	1	THERMOCOUPLE SELECTOR SWITCH	[illegible]	[illegible]	[illegible]-POSITION & OFF
3	1	PRESSURE DISPLAY PROPORTIONAL CONTROLLER	NEWPORT	[illegible]	[illegible] OUTPUT 4-20mA
2	2	TEMPERATURE DISPLAY	NEWPORT	[illegible]	TYPE "T" INPUT [illegible]
1	1	OPERATOR'S CONTROL PANEL	[illegible]		PART OF ITEM 1 [illegible]

LIST OF MATERIAL

VACUUM [illegible] FOOD PROCESSOR	
OPERATOR'S CONTROL PANEL ASSEMBLY	
	D12571



1 TEMPERATURE CONTROL PANEL ASSEMBLY

FRONT VIEW

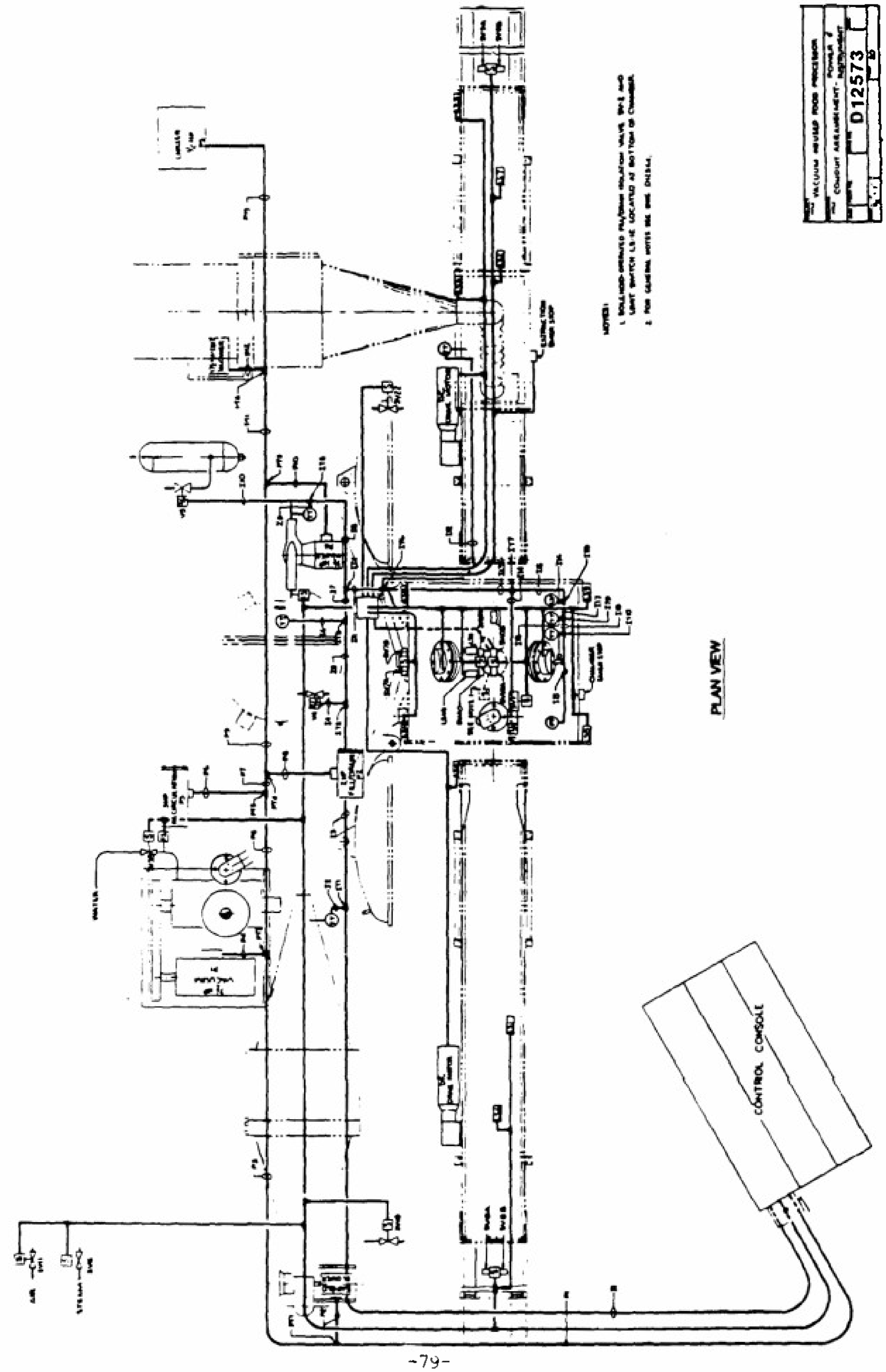
NOTES:

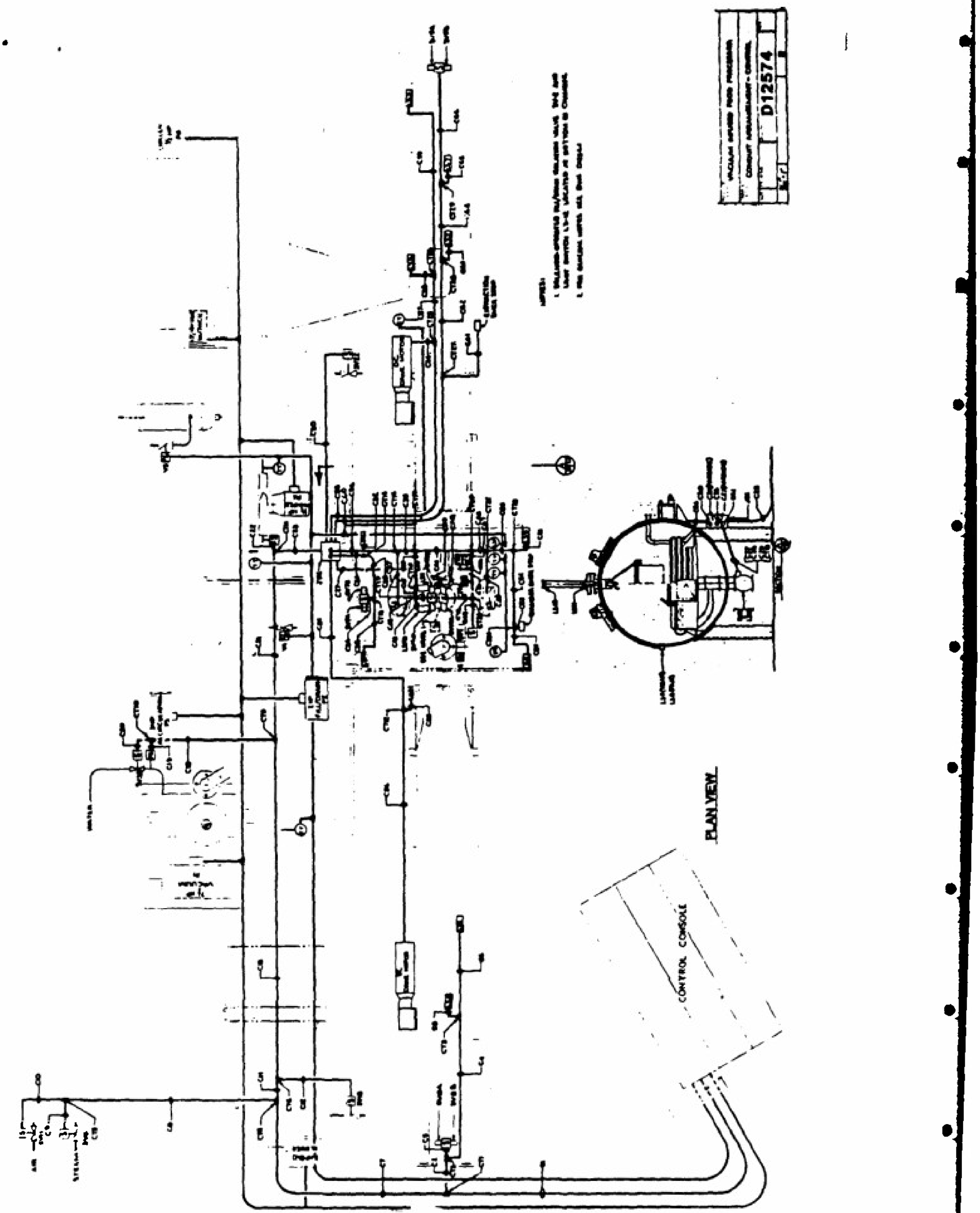
1. THE EQUIPMENT FOR THIS ASSEMBLY SHALL BE AS LISTED IN THE MATERIALS LIST OR OF EQUAL QUALITY AND PERFORMANCE.
2. ALL DIMENSIONS ARE APPROXIMATE AND FOR GUIDANCE ONLY.
3. ALL HOOK-UP WIRE STRANDED COPPER, THERMOPLASTIC INSULATED (PVC) NEC TYPE MTW-600 VOLT AND NO SMALLER THAN AWG 16, EXCEPTION ONLY FOR THERMOCOUPLE WIRE.
4. THE CONTRACTOR SHALL FURNISH ALL MISCELLANEOUS HARDWARE ITEMS SUCH AS SCREWS, NUTS, BRACKETS, HOSES, CLAMPS, TERMINAL LUGS, WIRE AND OTHER SMALL PARTS REQUIRED FOR THE FABRICATION OF THIS ASSEMBLY.
5. FOR GENERAL NOTES SEE DWG [illegible].

ITEM	QTY	DESCRIPTION	MFR	MF. PN.	REMARKS
3	1	SYSTEM TIMER CHANGER	[illegible]	[illegible]	[illegible]
2	2	PROGRAMMABLE TEMPERATURE CONTROLLER	OMEGA	[illegible]	[illegible]
1	1	TEMPERATURE CONTROL PANEL	[illegible]		PART OF ITEM 1 ON DWG [illegible]

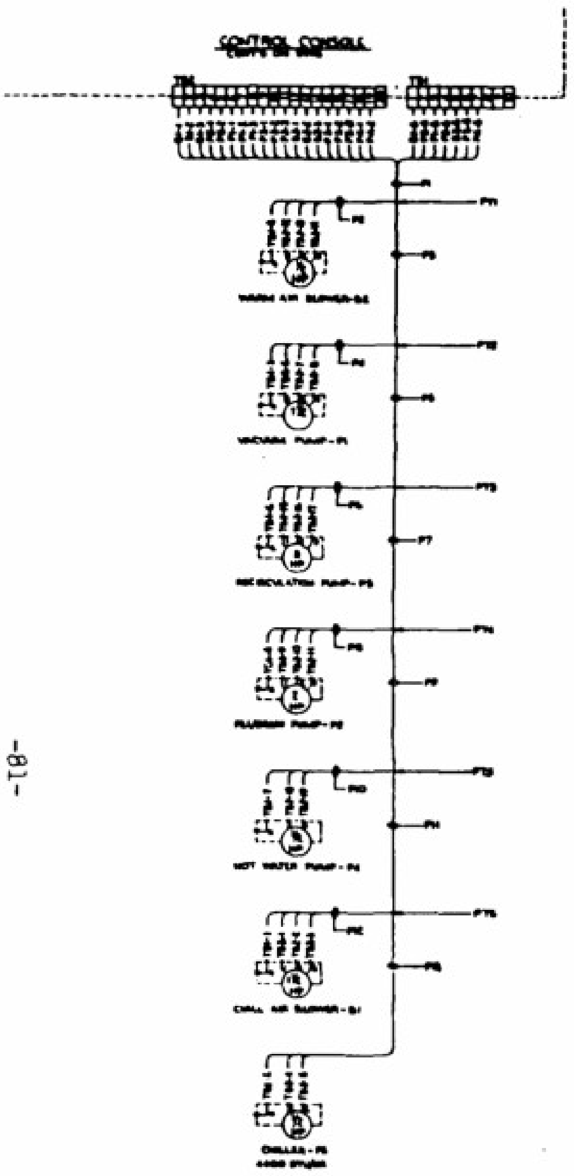
LIST OF MATERIAL

[illegible]	[illegible]
	TEMPERATURE CONTROL PANEL ASSEMBLY
	D12572


PLAN VIEW
CONTROL CONSOLE
D12573
WATER
AIR
STEAM


D12574
PLAN VIEW
CONTROL CONSOLE

NOTES:
1. FOR GENERAL NOTES SEE DWG D12544



CONDUIT/CABLE ASSEMBLY (CONT'D)

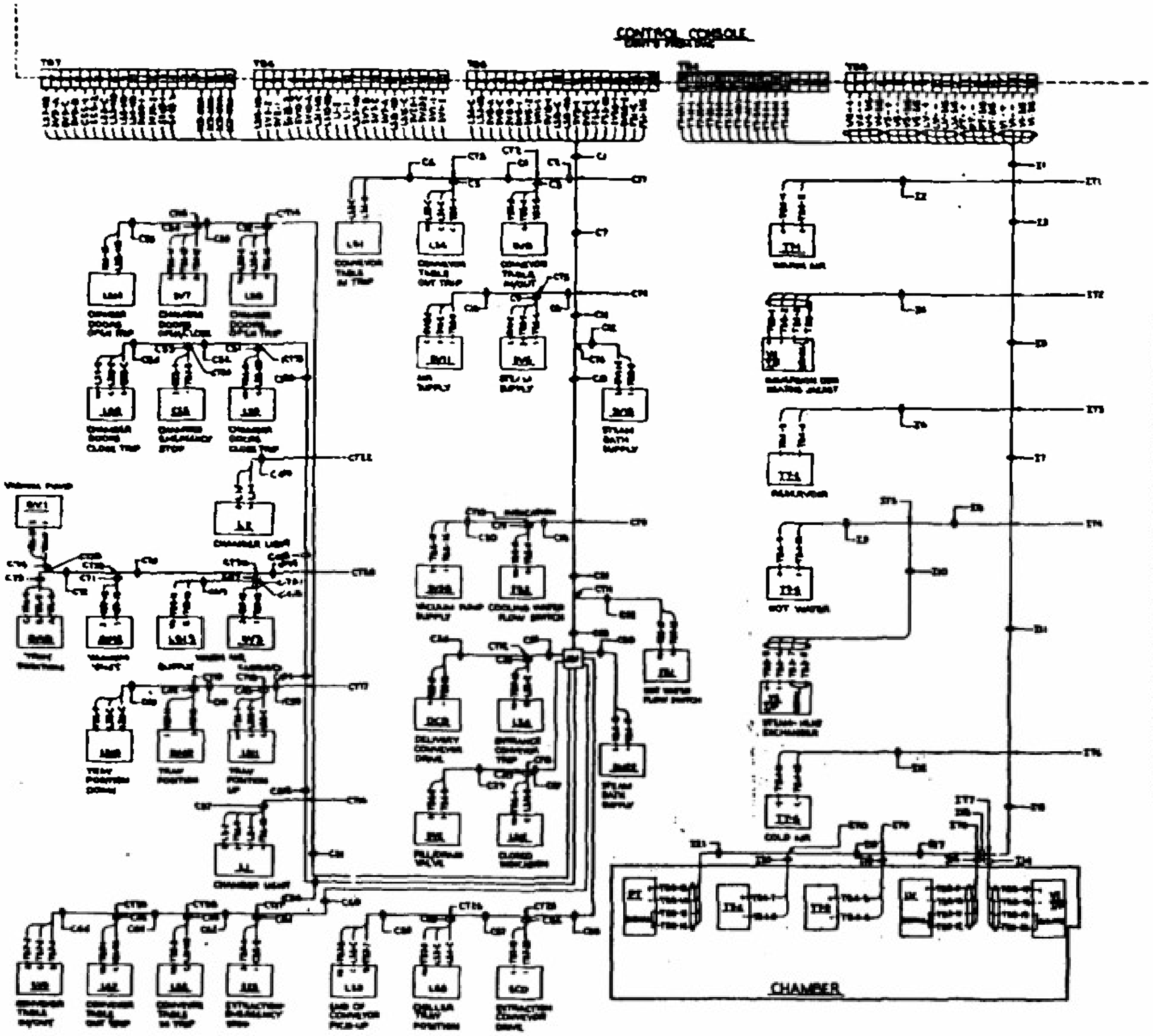
IDENT NO	COND SIZE	QUANTITY & SIZE OF CONDUCTORS	APPROX LENGTH	ROUTING DESCRIPTION
I9	[illegible]	(3) 2 CONDUCTOR, T/C EXTENSION WIRE, TYPE T		IT8 TO TT-6 ([illegible])
I10	[illegible]	(1) 4 CONDUCTOR, AWG NO 16 SHIELD		IT8 TO V-4 ([illegible])
I11	[illegible]	(3) 2 CONDUCTOR, T/C EXTENSION WIRE, TYPE T (2) 4 CONDUCTOR, AWG NO 16 SHIELD		IT4 TO IT6
I12	[illegible]	(1) 2 CONDUCTOR, T/C EXTENSION WIRE, TYPE T		IT6 TO TT-6 (COLD AIR)
I13	[illegible]	(5) 2 CONDUCTOR, T/C EXTENSION WIRE, TYPE T (2) 4 CONDUCTOR, AWG NO 16 SHIELD		IT6 TO IT7
I14	[illegible]	(1) 4 CONDUCTOR, AWG NO 16 SHIELD		IT7 TO V-1 ([illegible])
I15	[illegible]	(2) 2 CONDUCTOR, T/C EXTENSION WIRE, TYPE T (2) 4 CONDUCTOR, AWG NO 16 SHIELD		IT7 TO IT8
I16	[illegible]	(1) 4 CONDUCTOR, AWG NO 16 SHIELD		IT8 TO LV ([illegible])
I17	[illegible]	(3) 2 CONDUCTOR, T/C EXTENSION WIRE, TYPE T (1) 4 CONDUCTOR, AWG NO 16 SHIELD		IT8 TO IT9
I18	[illegible]	(1) 2 CONDUCTOR, T/C EXTENSION WIRE, TYPE T		IT9 TO TT-8 ([illegible])
I19	[illegible]	(2) 2 CONDUCTOR, T/C EXTENSION WIRE, TYPE T (1) 4 CONDUCTOR, AWG NO 16 SHIELD		IT9 TO IT10
I20	[illegible]	(1) 2 CONDUCTOR, T/C EXTENSION WIRE, TYPE T		IT10 TO TT-4 ([illegible])
I21	[illegible]	(1) 4 CONDUCTOR, AWG NO 16 SHIELD		IT10 TO PT ([illegible])
C1	[illegible]	([illegible]) 1 CONDUCTOR, AWG NO 14		CONTROL CONSOLE TO CT1
C2	[illegible]	([illegible]) 1 CONDUCTOR, AWG NO 14		CT1 TO CT2
C3	[illegible]	([illegible]) 1 CONDUCTOR, AWG NO 14		CT2 TO SV8
C4	[illegible]	([illegible]) 1 CONDUCTOR, AWG NO 14		CT2 TO CT3
C5	[illegible]	([illegible]) 1 CONDUCTOR, AWG NO 14		CT3 TO LS6
C6	[illegible]	([illegible]) 1 CONDUCTOR, AWG NO 14		CT3 TO LS1
C7	[illegible]	([illegible]) 1 CONDUCTOR, AWG NO 14		CT1 TO CT4
C8	[illegible]	([illegible]) 1 CONDUCTOR, AWG NO 14		CT4 TO CT5
C9	[illegible]	([illegible]) 1 CONDUCTOR, AWG NO 14		CT5 TO SV6
C10	[illegible]	([illegible]) 1 CONDUCTOR, AWG NO 14		CT5 TO SV11
C11	[illegible]	([illegible]) 1 CONDUCTOR, AWG NO 14		CT4 TO CT6
C12	[illegible]	([illegible]) 1 CONDUCTOR, AWG NO 14		CT6 TO SV9
C13	[illegible]	([illegible]) 1 CONDUCTOR, AWG NO 14		CT6 TO CT9
C18	[illegible]	([illegible]) 1 CONDUCTOR, AWG NO 14		CT9 TO CT10
C19	[illegible]	([illegible]) 1 CONDUCTOR, AWG NO 14		CT10 TO PS1
C20	[illegible]	([illegible]) 1 CONDUCTOR, AWG NO 14		CT10 TO SV10
C21	[illegible]	([illegible]) 1 CONDUCTOR, AWG NO 14		CT9 TO CT11
C22	[illegible]	([illegible]) 1 CONDUCTOR, AWG NO 14		CT11 TO PS1
C23	[illegible]	([illegible]) 1 CONDUCTOR, AWG NO 14		CT11 TO JB1
C24	[illegible]	([illegible]) 1 CONDUCTOR, AWG NO 14		JB1 TO CT12
C25	[illegible]	([illegible]) 1 CONDUCTOR, AWG NO 14		CT12 TO LS4
C26	[illegible]	([illegible]) 1 CONDUCTOR, AWG NO 14		CT12 TO ENTRANCE DRIVE MOTOR
C27	[illegible]	([illegible]) 1 CONDUCTOR, AWG NO 14		JB1 TO CT13
C28	[illegible]	([illegible]) 1 CONDUCTOR, AWG NO 14		CT13 TO LS12
C29	[illegible]	([illegible]) 1 CONDUCTOR, AWG NO 14		CT13 TO SV2
C30	[illegible]	([illegible]) 1 CONDUCTOR, AWG NO 14		JB1 TO SV12
C31	[illegible]	([illegible]) 1 CONDUCTOR, AWG NO 14		JB1 TO CT14
C32	[illegible]	([illegible]) 1 CONDUCTOR, AWG NO 14		CT14 TO LS13
C33	[illegible]	([illegible]) 1 CONDUCTOR, AWG NO 14		CT14 TO CT15
C34	[illegible]	([illegible]) 1 CONDUCTOR, AWG NO 14		CT15 TO SV7
C35	[illegible]	([illegible]) 1 CONDUCTOR, AWG NO 14		CT15 TO LS14
C36	[illegible]	([illegible]) 1 CONDUCTOR, AWG NO 14		JB1 TO CT16
C37	[illegible]	([illegible]) 1 CONDUCTOR, AWG NO 14		CT16 TO L1
C38	[illegible]	([illegible]) 1 CONDUCTOR, AWG NO 14		CT16 TO CT17
C39	[illegible]	([illegible]) 1 CONDUCTOR, AWG NO 14		CT17 TO CT18
C40	[illegible]	([illegible]) 1 CONDUCTOR, AWG NO 14		CT18 TO LS11
C41	[illegible]	([illegible]) 1 CONDUCTOR, AWG NO 14		CT18 TO CT19

CONT'D ON DWG NO D12576

CONDUIT/CABLE ASSEMBLY CHART

IDENT NO	COND SIZE	QUANTITY & SIZE OF CONDUCTOR	APPROX LENGTH	ROUTING DESCRIPTION
P1	1"	([illegible]) 1 CONDUCTOR, AWG NO 10 (1) 1 CONDUCTOR, AWG NO 10 (GND) ([illegible]) 1 CONDUCTOR, AWG NO 14 ([illegible]) 1 CONDUCTOR, AWG NO 14 (GND)		CONTROL CONSOLE TO PT1
P2	[illegible]	([illegible]) 1 CONDUCTOR, AWG NO 14 (1) 1 CONDUCTOR, AWG NO 14 (GND)		PT1 TO [illegible] HP MOTOR B2
P3	1"	([illegible]) 1 CONDUCTOR, AWG NO 10 (1) 1 CONDUCTOR, AWG NO 10 (GND) ([illegible]) 1 CONDUCTOR, AWG NO 14 ([illegible]) 1 CONDUCTOR, AWG NO 14 (GND)		PT1 TO PT2
P4	[illegible]	([illegible]) 1 CONDUCTOR, AWG NO 10 (1) 1 CONDUCTOR, AWG NO 10 (GND)		PT2 TO [illegible] HP MOTOR P1
P5	[illegible]	([illegible]) 1 CONDUCTOR, AWG NO 14 ([illegible]) 1 CONDUCTOR, AWG NO 14 (GND)		PT2 TO PT3
P6	[illegible]	([illegible]) 1 CONDUCTOR, AWG NO 14 (1) 1 CONDUCTOR, AWG NO 14 (GND)		PT3 TO 3HP MOTOR P3
P7	[illegible]	([illegible]) 1 CONDUCTOR, AWG NO 14 ([illegible]) 1 CONDUCTOR, AWG NO 14 (GND)		PT3 TO PT4
P8	[illegible]	([illegible]) 1 CONDUCTOR, AWG NO 14 (1) 1 CONDUCTOR, AWG NO 14 (GND)		PT4 TO 2HP MOTOR P2
P9	[illegible]	(7) 1 CONDUCTOR, AWG NO 14 ([illegible]) 1 CONDUCTOR, AWG NO 14 (GND)		PT4 TO PT5
P10	[illegible]	([illegible]) 1 CONDUCTOR, AWG NO 14 (1) 1 CONDUCTOR, AWG NO 14 (GND)		PT5 TO [illegible] HP MOTOR P4
P11	[illegible]	([illegible]) 1 CONDUCTOR, AWG NO 14 ([illegible]) 1 CONDUCTOR, AWG NO 14 (GND)		PT5 TO PT6
P12	[illegible]	([illegible]) 1 CONDUCTOR, AWG NO 14 (1) 1 CONDUCTOR, AWG NO 14 (GND)		PT6 TO [illegible] HP MOTOR B1
P13	[illegible]	(2) 1 CONDUCTOR, AWG NO 14 (1) 1 CONDUCTOR, AWG NO 14 (GND)		PT6 TO CHILLER P5
I1	[illegible]	([illegible]) 2 CONDUCTOR, T/C EXTENSION WIRE, TYPE T ([illegible]) 4 CONDUCTOR, AWG NO 16 SHIELD		CONTROL CONSOLE TO IT1
I2	[illegible]	([illegible]) 2 CONDUCTOR, T/C EXTENSION WIRE, TYPE T		IT1 TO TT-1 (WARM AIR)
I3	[illegible]	([illegible]) 2 CONDUCTOR, T/C EXTENSION WIRE, TYPE T ([illegible]) 4 CONDUCTOR, AWG NO 16 SHIELD		IT1 TO IT2
I4	[illegible]	(1) 4 CONDUCTOR, AWG NO 16 SHIELD		IT2 TO V-4 ([illegible])
I5	[illegible]	([illegible]) 2 CONDUCTOR, T/C EXTENSION WIRE, TYPE T ([illegible]) 4 CONDUCTOR, AWG NO 16 SHIELD		IT2 TO IT3
I6	[illegible]	([illegible]) 2 CONDUCTOR, T/C EXTENSION WIRE, TYPE T		IT3 TO TT-2 ([illegible])
I7	[illegible]	([illegible]) 2 CONDUCTOR, T/C EXTENSION WIRE, TYPE T ([illegible]) 4 CONDUCTOR, AWG NO 16 SHIELD		IT3 TO IT4
I8	[illegible]	([illegible]) 2 CONDUCTOR, T/C EXTENSION WIRE, TYPE T ([illegible]) 4 CONDUCTOR, AWG NO 16 SHIELD		IT4 TO IT8

VACUUM [illegible] FOOD PROCESSOR
INTERCONNECTION DIAGRAM
SHEET 1 OF 2
D12575



CONDUIT/CABLE ASSEMBLY CHART (CONT'D FROM [illegible])

CONDUIT NO.	COND SIZE	QUANTITY & SIZE OF CONDUCTOR	LENGTH	ROUTING DESCRIPTION
C42	[illegible]	[illegible] CONDUCTOR, AWG #14		[illegible]
C43	[illegible]	[illegible] CONDUCTOR, AWG #14		[illegible]
C44	[illegible]	[illegible] CONDUCTOR, AWG #14		[illegible]
C45	[illegible]	[illegible] CONDUCTOR, AWG #14		[illegible]
C48	[illegible]	[illegible] CONDUCTOR, AWG #14		[illegible]
C49	[illegible]	[illegible] CONDUCTOR, AWG #14		[illegible]
C50	[illegible]	[illegible] CONDUCTOR, AWG #14		[illegible]
C51	[illegible]	[illegible] CONDUCTOR, AWG #14		[illegible]
C52	[illegible]	[illegible] CONDUCTOR, AWG #14		[illegible]
C53	[illegible]	[illegible] CONDUCTOR, AWG #14		[illegible]
C54	[illegible]	[illegible] CONDUCTOR, AWG #14		[illegible]
C55	[illegible]	[illegible] CONDUCTOR, AWG #14		[illegible]
C56	[illegible]	[illegible] CONDUCTOR, AWG #14		[illegible]
C57	[illegible]	[illegible] CONDUCTOR, AWG #14		[illegible]
C58	[illegible]	[illegible] CONDUCTOR, AWG #14		[illegible]
C59	[illegible]	[illegible] CONDUCTOR, AWG #14		[illegible]
C60	[illegible]	[illegible] CONDUCTOR, AWG #14		[illegible]
C61	[illegible]	[illegible] CONDUCTOR, AWG #14		[illegible]
C62	[illegible]	[illegible] CONDUCTOR, AWG #14		[illegible]
C63	[illegible]	[illegible] CONDUCTOR, AWG #14		[illegible]
C64	[illegible]	[illegible] CONDUCTOR, AWG #14		[illegible]
C65	[illegible]	[illegible] CONDUCTOR, AWG #14		[illegible]
C66	[illegible]	[illegible] CONDUCTOR, AWG #14		[illegible]
C67	[illegible]	[illegible] CONDUCTOR, AWG [illegible]		[illegible]
C68	[illegible]	[illegible] CONDUCTOR, AWG [illegible]		[illegible]
C69	[illegible]	[illegible] CONDUCTOR, AWG [illegible]		[illegible]
C70	[illegible]	[illegible] CONDUCTOR, AWG [illegible]		[illegible]
C71	[illegible]	[illegible] CONDUCTOR, AWG [illegible]		[illegible]
[illegible]	[illegible]	[illegible] CONDUCTOR, AWG [illegible]		[illegible]
[illegible]	[illegible]	[illegible] CONDUCTOR, AWG [illegible]		[illegible]
[illegible]	[illegible]	[illegible] CONDUCTOR, AWG [illegible]		[illegible]

INTERCONNECTION DIAGRAM

SHEET 1 OF 2

D12576